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USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

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UDC 669.71-492.3:539.374

DEPENDENCE OF SUPERPLASTIC FLOW ON STATE OF GRAIN BOUNDARIES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 1, Sep 84
(manuscript received 24 Nov 83) pp 93-97

KAYBYSHEV, O. A., VALIYEV, R. Z. and TSENEV, N. K., Ufa Aviation Institute imeni S. Ordzhonikidze

[Abstract] An experimental study of Al+ 2 atom.% Mg+ 0.10 atom.% Zr and Al+ 2 atom.% Cu+ 0.16 atom.% Zr was made for the purpose of determining the dependence of superplastic flow with attendant grain fragmentation on the state of grain boundaries. Specimens of these two alloys are producible with an equally ultrafine initial grain size but different initial states of the grain boundaries. Such specimens were produced by crystallization at high cooling rates, resulting in a solid solution with oversaturation of zirconium in aluminum, and subsequent heterogenization through annealing at 653°K for precipitation of disperse Al_3Zr particles prior to successive cold and hot deformation into an ultrafine structure (particle diameter D_0= 8 μm). Three major factors influencing superplastic flow were examined: kind of grain boundary, structural unbalance, and presence of disperse precipitates. While more than 90% of all grain boundaries in the Al-Cu-Zr alloy had initially a plain arbitrary disorientation and more than 70% of all grain boundaries in the Al-Mg-Zr alloy had initially a special or quasi-special orientation, deformation to a 200% strain level resulted in an equally arbitrary disorientation of grain boundaries in both alloys. Structural unbalance of grain boundaries, caused by pinning of lattice dislocations and causing a change of energy levels, was found to increase the stress in the material with special grain boundaries and to decrease the stress in the material with plain grain boundaries during deformation up to a 50% strain level at room temperature. Upon further deformation, each material with unbalanced grain boundaries reverted to its initial behavior. The role of disperse precipitates on grain boundaries was established by cold predeformation of specimens to a 3% strain level and subsequent annealing at 573°K for 48 hrs. This resulted in precipitation of $CuAl_2$ particles of 0.2-0.4 μm size in the Al-Cu-Zr alloy and in no precipitation in the Al-Mg-Zr alloy. Precipitates in the Al-Cu-Zr alloy dissolved during superplastic deformation and vanished upon deformation to a 300% strain level. Accordingly, precipitates on grain boundaries impede rather than improve superplastic flow and do not increase the structural stability of grain boundaries. An alloy with

specially oriented grain boundaries will have worse superplastic characteristics than one with plain disoriented grain bourdaries, because of weaker absorption of lattice dislocations and resulting slower slippage of grain boundaries. Article was presented by Academician A. A. Bochvar on 23 November 1983. Figures 4; references 12: 8 Russian, 4 Western.
[27-2415]

UDC 669.75(031)

FATIGUE AND CORROSION FATIGUE RESISTANCE OF ALUMINUM CASTING ALLOY VAL10 AND FORGING ALLOY AK6

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 4, Jul-Aug 84 (manuscript received 30 May 83) pp 47-49

KARLASHOV, A. V., GNATYUK, A. D., POLISHCHUK, V. M. and BELETSKIY, V. M., Kiev Institute of Civil Aviation Engineers

[Abstract] Results are presented from experimental studies of the influence of a 3% aqueous NaCl solution on the fatigue resistance to fracture upon cyclical loading of aluminum casting alloy VAL10 and forging alloy AK6, selected for comparison. The new alloy VAL10 is quite promising in terms of mechanical properties for casting important load-bearing parts of products. The formable alloy AK6 is the closest in its static loading properties to VAL10. VAL10, having significantly less fatigue resistance in air than forging alloy AK6, does have satisfactory yield point in a corrosive medium with a long test base, 30% lower than AK6, and can therefore be used for the manufacture of lightly loaded parts. Figures 2; references 2: both Russian.
[013-6508]

UDC 539.43:669.715

STRUCTURAL STRENGTH OF STRIP OF D16T ALUMINUM ALLOY WITH LOW COPPER AND MAGNESIUM CONTENT

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 84 (manuscript received 4 Aug 83) pp 54-58

NESHPOR, G. S., ARMYAGOV, A. A. and BEREZHNAYA, G. I., Moscow and Belaya Kalitva

[Abstract] The static strength and fatigue limits of D16T aluminum alloy containing only 4.17 wt.% Cu and 1.20 wt.% Mg have been determined on the basis of 43 specimens of 1.85-mm-thick plated strip from the same ladle. Specimens of various widths and gauge lengths correspondingly equal to 5.65 /F (F- area of cross section) were tested mechanically for 0.2% yield strength, tensile strength, and percent elongation. The cracking rate under

slow-cycle (3 Hz) and fast-cycle (40 Hz) loads was determined through statistical processing of corresponding data, the fatigue limit in each case being found from the dependence of crack length increment on the cumulative number of cycles--with the crack length increasing steeply toward the end of life. Toughness and ductility of fracture were determined from histograms of net stress characterizing the residual strength. The results of this study reveal a correlation between the given strength characteristics and indicate the ranges of their variation, typical of aluminum alloys in this group. Figures 5; references 10: all Russian.
[29-2415]

UDC 669.715.620.1

TEMPERATURE EFFECTS OF HETEROGENIZATED ANNEALING ON STRUCTURE AND PROPERTIES OF V95 ALUMINUM ALLOY

Moscow TSVETNYYE METALLY in Russian No 10, Oct 84 pp 73-76

ZAKHAROV, V. V. and KUKUSHKIN, Yu. N.

[Abstract] Heterogenizated annealing of aluminum ingots after homogenization and before pressing is used to increase deformation, at an optimum temperature equal to that of minimal durability. The present article reports on attempts to explain the deformation increases obtained by this method with solid solutions of Zn, Mg and Cu in aluminum, by an electrical conductivity method. Additional analysis relates to the morphology of excess phase particles emitted during annealing. Particles larger than 10 mkm did not increase resistance to deformation during pressing or reduce surface purity of semi-manufactured products. Thermal and structural findings are summarized. Results showed that the pressure at initiation of pressing followed a curve with a pronounced minimum in a C-form. A temperature of 325°C provided effective annealing. Longitudinal mechanical properties did not depend on the annealing temperature. Figures 3; references 7: 5 Russian, 2 Western.
[33-12131]

UDC 669.715'782-402/404.018

ANOMALIES OF ALUMINUM STRUCTURE AND PROPERTIES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 1, Sep 84 (manuscript received 23 Dec 83) pp 97-100

KRUSHENKO, G. G. and TORSHILOVA, S. I., Krasnoyarsk Institute of Nonferrous Metals imeni M. I. Kalinin

[Abstract] The known effect of superheating liquid aluminum, namely decrease of the number of nucleation centers and enlargement of its macrocrystallite, was studied experimentally for the purpose of establishing the mechanism of

this anomaly from the standpoint of heat treatment technology. Molten aluminum was superheated to 943-1093-1223-1353°K, pure A999 aluminum as well as A99 to A0 aluminum with 0.008-0.096 wt.% Be, 0.009-0.42 wt.% Mg, 0.012-0.42 wt.% Si, 0.012-0.1 wt.% Ti, 0.01-0.42 wt.% Fe, 0.052-0.62 wt.% Cu, 0.003-0.35 wt.% Mn, 0.009-0.16 wt.% Zr inpurities. Raising the temperature of superheat and pouring to 1093°K was found to result in sudden coarsening of the grain structure of all melts. Impurity thus not being the cause of this anomaly, transformation of the short-range order from c.p.h. to b.c.c. structure appears to be the most likely mechanism. While the c.p.h. structure continues to exist up to 1093°K and only its parameters gradually change, enlargement of the grain occurring within the 1083-1088°C range, the b.c.c. structure continues to exist above 1093°K with an almost stable grain size. This hypothesis is confirmed by results of an earlier experiment by these authors. There A999 aluminum was melted in an Alundum crucible inside an electrical resistance furnace and high-purity iron was injected by the rotating-disk method at 1053°K, 1063°K, 1073°K, 1083°K, 1093°K, 1103°K, and 1113°K. Specimens formed by turning from ingots cast separately at each temperature were tested for mechanical characteristics, macrocrystallite size, and magnetic susceptibility in the liquid state. The results revealed a maximum solubility of iron at about 1073°K, with consequently minimum macrocrystallite size and poorest mechanical properties of aluminum with the highest $FeAl_3$ content. Another confirmation of the hypothesis are data based on neutron irradiation of aluminum in the solid state in experiments performed by other authors. Article was presented by Academician Yu. A. Osip'yan on 12 October 1983. References 12: 8 Russian, 4 Western.
[27-2415]

UDC 669.715.48

NEW DEFORMABLE SECONDARY ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 84 pp 74-76

GOL'DBUKHT, G. Ye. and ANAN'IN, S. N.

[Abstract] Two new secondary aluminum alloys have been developed and tested. The V95-1 alloy belongs in the Al-Cu-Mg-Zn system with up to 1% Fe and 1.5% Si, in chemical composition being intermediate between the two commercial secondary alloys V95-2 and VD1. The AMM alloy belongs in the Al-Mg system and is available in two variants: AMM-1 with 1.4-4.2% Mg and 0.6-1.8% Cu is hardenable by quenching and aging, AMM-2 with 0.8-5.0% Mg and up to 0.5% Cu impurity is not hardenable by heat treatment. Both variants contain silicon (0.3-1.4% and 0.3-2.0% respectively) and zinc (up to 0.8% and 1.5% respectively), and can also contain iron (up to 0.9% and 1.5% respectively). Both variants of the AMM alloy and the V95-1 alloy have been thoroughly tested, after annealing and after hardening, for mechanical characteristics: tensile strength, 0.2% yield strength, percent elongation, resilience, toughness, and fatigue limits. The results have been evaluated statistically. The cost advantage of these secondary alloys over corresponding primary ones is at least 200 rubles/ton. Figures 3.
[31-2415]

UDC 669./1'/82

STUDY OF PROCESSES OF MODIFICATION OF Al-Si ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 84 pp 57-59

KIMSTACH, G. M., MUKHOVETSKIY, Yu. P., BORISOV, V. D., LOBANOV, S. V., Aviation Technology Institute, Andropov

[Abstract] A study is made of the process of modification of hypereutectic Al-Si alloys with phosphorus. It was found that in contrast to sodium, phosphorus does not increase the tendency of Al-Si melts toward gas saturation. Vacuum samples of the liquid metal before and after modification remain compact. Neither sodium nor phosphorus has a significant influence on the process of crystallization of aluminum. The change observed in the nature of crystallization of the Al-Si melt as a result of modification by various modifiers thus results not from an interaction of the atoms of aluminum, but rather primarily from changes in the nature of the Al-Si interaction in the modified alloy. Modification of Al-Si alloys with sodium leads to an increase in the Al-Si bond strength retaining the silicon atoms in the structure of the alloy, thus creating conditions for eutectic silicon particle size reduction. Modification with phosphorus probably causes weakening of the Al-Si chemical interaction, as a result of which the Al-Si bond forces become weaker and in the process of crystallization of the modified melt the silicon atoms are expelled from the bond with aluminum. This changes the conditions of birth of silicon crystallization centers and their growth. Figures 2; references 10: all Russian.
[001-6508]

UDC 621.1:546.621.27

USE OF ACOUSTICAL EMISSION METHOD TO STUDY SPECIFICS OF FRACTURE OF BORON REINFORCED PLASTIC STRUCTURAL ELEMENTS

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 7 Sep 83) pp 26-32

STRIZHALOV, V. A., DOBROVOL'SKIY, Yu. V., ZEMTSOV, M. P. and LIKHATSKIY, S. I., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] Tests were performed in extension and compression on specimens consisting of a metal cylindrical shell made of D16T aluminum alloy, a reinforcing elements (a rod of boron-reinforced plastic) and the combination of the two parts of the structure. Acoustical emission signals and the applied load were recorded on an oscillograph. It is found that acoustical emission can determine the beginning of fracture of the most heavily loaded component of a composite material--the boron fibers. The failure of the boron fibers occurs at very small deformations, quite safe for the epoxy binder and

aluminum alloy component. For this reason, tensometry and visual examination of structural elements of this type cannot reveal whether failure of the boron fibers has begun. The method of acoustical emission can record individual boron fiber failure events. Figures 5; references 6: 5 Russian, 1 Western.
[005-6508]

UDC 669.715

ALUMINUM ALLOY AT35K5 (5% Zn + 5% Ca) FOR SUPERPLASTIC FORMING

Moscow TSVETNYYE METALLY in Russian No 9, Sep 84 pp 72-74

PORTNOY, V. K., STEPANOV, B. N., LISKIN, A. M. and IL'YENKO, V. M.

[Abstract] A new aluminum alloy with 5% Zn and 5% Ca has been developed for superplastic forming which, unlike the special Supral alloy, can be produced with moderate cooling rates during crystallization in the semicontinuous casting process. Selection of this alloy composition is based on an experimental evaluation of three alloys close to the α -Al_3ZnCa double-eutectic line in the aluminum corner of the Al-Zn-Ca ternary constitution diagram: hypoeutectic 4.4 Zn + 4.9 Ca (0.08 Fe, 0.1 Si), eutectic 4.5 Zn + 5.2 Ca (0.12 Fe, 0.12 Si), hypereutectic 4.8 Zn + 6.3 Ca (0.02 Fe, 0.1 Si). Ingots of these alloys were produced by continuous casting at rates of 60-100 mm/min into a tilt crystallizer at 700-720°C. For microstructural analysis of the eutectic alloy, ingots were fragmented into strips by successively hot and cold rolling. This alloy was found to have high resistance to parting and general corrosion, low sensitivity to intergranular and pitting corrosion, and high resistance to corrosion cracking with attendant low residual stress and large residual sag. Tests peformed on easier producible strips of the hypoeutectic alloy have revealed that the mechanical properties at room temperature do not depend on the calcium content and that softening occurs at 550°C, the optimum temperature for superplastic deformation. The hypereutectic alloy has the least percent elongation, evidently because of microvoids clustering around Al_3ZnCa-phase grains, despite its high sensitivity of flow stress to strain rate. All three alloys are weldable, especially under pressure, and can be anodized or aluminum clad for surface coloration. Corrosion tests were performed by V. D. Val'kov and K. I. Makarova. Figures 5; references 3: 2 Russian, 1 Western.
[31-2415]

COMPOSITE MATERIALS

USES OF COMPOSITE MATERIALS

Vilnyus KOMSOMOL'SKAYA PRAVDA in Russian 12 May 84 No 93 p 3

[Article by V. Dovidenas: "Composites--the materials of the future"]

[Text] The first man to walk on the moon left the lunar module on a remarkably light ladder made from composite materials. The design of the lunar module included still other parts made from composites such as the ceiling, side panels and the "balcony" on which the astronauts stood before descending to the lunar surface.

Composites are being used very boldly in sports aviation. The record-making Soviet Letuva glider manufactured in 1972 is made almost entirely from composite materials. No metal or wooden glider can compare with the Letuva in terms of lightness and performance. It has an unusually elegant appearance and perfectly flat wing surfaces with a wingspan only slightly less than that of a jet airliner. At many exhibits of Soviet industry, the Letuva always draws much attention.

Engineers in many areas of technology are making increasing use of composite materials. In the United States, only 1.8 percent of the entire production of fiberglass is consumed by the aviation and aerospace industries. Manufacturers of items of surface transporation such as automobiles, railway rolling stock and shipping containers take up a large share of the production --30 percent. Another 20 percent of the production is taken by the shipbuilding industry while 14 and 10 percent are used by the construction and chemical industires respectively. Consumer goods and sporting goods in particular take up 5 percent of these unusually light and strong materials. Glass-reinforced plastics can be used to manufacture items ranging from windsurfers to ski poles. In the future, composite materials will be used to make skis, furniture frames, transparent roofing, bicyles and even automobiles.

The first airplane with a fiberglass fuselage took off in 1944. Since then, the use of composite materials has produced very pleasing results. As we know, transport airplanes have a service life of 15 years and about half of this time is spent in the air. Composite materials used in these aircraft have passed the test on fatigue without a single catastrophe in which they were found to be a direct or indirect cause.

Composites can offer completely new possibilities. For example, they can be used to built aircraft which are transparent and almost invisible to human eye or radar.

What sort of materials are these with such a unique set of properties? As a minimum, they can be composed of two component fibers and a matrix. The secret of high-strength materials lies in the fact that they are made in the form of fibers, usually about 10 microns in diameter or about 7 times finer than a human hair. Glass fibers are several times stronger than steel. However, by themselves, glass fibers are very thin and cannot stand up to an external load. Let us compare fiber to a crow's feather which can be easily broken. It should be bound by a matrix such as plastic or aluminum. More frequently, the matrix material used to bind fibers is epoxy resin which usually forms about half of the mass of the composite while the other half is super-strong fibers. This resin, which is generally a fragile material on its own, attains entirely new strength in a composite.

A fiberglass baton will have the same strength as a steel bar of the same size but with four times less mass. It is also true that the fiberglass baton will be four times more flexible. For many structures, however, flexibility is an extremely undesirable property. In such cases, carbon-reinforced plastic which is just as rigid as steel is used. Unfortunately, carbon fiber now costs more than high-quality wool yarn and several hundred times more than glass fiber. It is expected that the cost of carbon fibers can be lowered if they ever become mass-produced.

It is an unquestionable fact that the high performance expected of modern machinery compels wider use of the surprising light weight and durability of composites. One kilogram of economized mass in spacecraft may cost 50,000 dollars and as much as 500 dollars in transport aviation. In this case, however, the expense of composites is not of decisive importance.

Let us consider the advantages of a reduction in the weight of such an ordinary machine as an automobile. After 15 years of service, it needs about 30 tons of fuel. If composites were to cut its mass in half, the fuel savings according to contemporary prices would amount to about 4000 rubles, i.e. about twice the value of the composites used. This does not even take into account the reduction in pollution, the lowered consumption of scarce fuel and reduced corrosion. The cost of composite materials is going down while fuel costs are rising. It is inevitable that we will have to lower the weight of heavy automobiles that are now unjustly called "light" vehicles. A kilogram of petroleum used to manufacture reinforced plastic may save an entire pailful of gasoline. With this in mind, the steel body design of a light automobile may have already become an anachronism. It is true that a 2.54-mm sheet of fiberglass needed to replace a 0.9-mm sheet of steel will be three times more expensive, but this does lower the automobile body weight by 40 percent. The enormous 1.8 x 3 m body of the well-known Corvette is made of fiberglass and weighs only 24 kg. This is 25-50 percent lighter even in comparison to titanium or aluminum alloy structures. At this time, however, the technology for the mass-production of steel automotive bodies is more highly-developed; thus, under the sharp competition in the automotive

industry, reinforced plastics are only a sign of technical progress and are only feasible at this time for small-lot production. Fiberglass bodies have already been found to be the least expensive ones for trucks and racecars.

The use of aviation materials, light alloys and composites, in the mass production of light automobiles will become standard procedure. It is predicted that by the year 2000, half of the mass of all automobiles will be made up of plastic. We must say that reinforced fiberglass, just like metal, does not become deformed under stress. Hoods of fiberglass cannot be dented by a strong blow of the fist because they spring back to their former shape. Still another important advantage is that a fiberglass hood insulates against vibration and noise. Loud aircraft engine noises are successfully dampened by composite material screens in the cabin.

Fiberglass may be used to make parts of any size or shape. It is important that a unit made of many metal parts can be replaced by a single plastic panel. The most important parts of the Letuva glider, 12-meter long wing longerons, are being made from carbon-reinforced plastic at the Prenaysk Sport Aviation Experimental Factory. High-quality composites must be hardened at high pressure and temperature. Their stability and strength can only be guaranteed under these conditions. At the factory, this technology has been mastered in full using Soviet-made equipment. In our country, the Prenaysk plant is a pioneer in the introduction of all-plastic reinforced structures. Its success in the composite materials technology has often been noted at international exhibits. In cost-accounting, the Prenaysk plant now shares its experience with such remote neighbors as agriculture.

Everyone is familiar with the high quality of fiberglass boats. This material does not deteriorate in any type of water and has a long service life. Aluminum is more often used for small boats but boats of over 60 meters in length may be made from fiberglass. They are 50 percent lighter than steel boats. It is interesting that as early as 1844, reinforced concrete, which in itself can be considered a macrostructural composite material, was used to build boats. One hundred years later, similar material was used in Italy to build a motor yacht which is still in use today. The USSR has conducted studies which show that ferroconcrete can be used to build hulls of up to 100 tons in water displacement.

In construction, the use of reinforced plastics has so far been limited by their unknown longevity. In this case, the service period of these materials after 25 years is regarded as "youth." The unique property of these materials lies in the fact that the support structures let in light. They can also be used to make shells of mixed curvature and a high-degree of rigidity. The 20-story Greater London Council building was constructed using wall panels of composite materials. Their mass is one-fifth that of concrete walls.

The chemical industry uses a large amount of pipes, containers, equipment and pumps made from fiberglass that is highly resistant to acids and other chemical agents.

All the same, we can only be surprised at the degree to which composite materials have gradually become a part of our lives. At the present time, it is only their high cost that has slowed their even broader use. If fiberglass

is cheaper than aluminum, then epoxy resin is three times more expensive. A kilogram of finished fiberglass product costs about 5 rubles. We would like to add that the process of fiberglass forming has still not been improved. Although it is in principle not particularly difficult, it does call for mainly manual labor with harmful vapors and irritating fibers. Although there do exist 16 different methods of mechanized fiberglass working, only two or three of these are ever used and most of the work is still done manually. In order to take full advantage of small structures, designers should have an exact knowledge of the distribution of stresses and use reinforcing material accordingly. Design work requires a high degree of perfection because excessive mass is economically harmful. In replacing the steel chassis of the Vilnyus-82 velomobile for a fiberglass body, we were unable to achieve any noticeable weight economy. Fiberglass is an excellent material for fairings but it is less useful for rigid frames. The position may save a small amount of rigid fiberglass on the part surfaces. This is known as "local hardening."

This made it possible to reduce by 40 percent the weight of fiberglass racecar bodies even though its cost was proportionally increased. It was also possible to produce a nearly four-meter-long racing kayak that weighed only 9.5 kg and an equally rigid cross-country bicycle frame was made which weighed 20 percent less than a steel frame. It is expected that a large amount of carbon-reinforced plastics will also be used for the production of such items.

High-quality composites are being designed not only for the manufacture of important parts such as fuselage frames or the rear propeller shafts of helicopters. They are also being tested for use in making gears, engine cases, prosthetic devices, elevator parts, robots and even bridges.

There is a multitude of natural structures made from composites: trees are made of lignin and cellulose and bones are formed from mineral apatite and collagenous protein. The unit strength (strength divided by the actual weight) of pine is no worse than that of steel or aluminum alloy. Of course, there are no known metal structures in nature. About 60 percent of steel produced goes into replacement of many different parts, most of which have become corroded.

What is a "substitute," composites or metals? This is a question that will be decided in the future. Most likely, composites and metals will be used to complement each other.

What are the latest innovations in the area of composite materials? The greatest achievement has been the creation of organic fibers (such as kevlar) with record-making strength. Bullet-proof vests are being made from kevlar.

12261
CSO: 8144/0062

WORK ON FUTURE COMPOSITE MATERIALS VIEWED

Minsk SOVETSKAYA BELORUSSIYA in Russian 27 Nov 84 p 3

SVIRIDENOK, A., corresponding member of the Belorussian Academy of Sciences, director of the academy's Institute of Mechanics of Metal-Polymer Systems

[Abstract] The article is published on the occasion of the Sixth Belorussian Republic Scientific-Technical Conference "Composite Materials Based on Polymers". The conference opened November 27 in Gomel', where the Belorussian Academy of Sciences' Institute of Mechanics of Metal-Polymer Systems is located. This institute coordinates basic and applied research in the republic on the development and use of new polymer-based composite materials. The author mentions some new types of composites with corrosion-resistant and other special properties which the institute has developed for industry and agriculture, and he calls attention to tasks for improving science-industry ties and the supplying of materials for research in line with scientific-technical programs in this field.

In conclusion, the author comments on the goal of developing so-called 'smart omposites' which will be capable of altering their properties in a purposeful way depending on external factors. He says:

"The first attempts to develop such materials and structures have already been made at our institute. Specifically, the use of liquid-crystal and magnetosensitive systems as functional additions to solid and liquid composite materials permits these composites' properties to be contro-led effectively. The encapsulating of granules of mineral fertilizers with polymer films possessing ion conductivity makes it possible to regulate the release of nutrients to plants depending on the moisture content of the environment. The use of polymer components possessing a 'deformation memory effect' in composites makes it possible to create remotely self-adjusting actuating mechanisms."

FTD/SNAP
CSO: 1842/50

UDC 539.432.620.194

INFLUENCE OF 3% NaCl SOLUTION ON RATE OF ACCUMULATION OF DAMAGE AND RESIDUAL STRENGTH OF ALUMINUM-BORON COMPOSITE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 4, Jul-Aug 84 (manuscript received 8 Apr 83) pp 52-55

UTKIN, V. S. and PODOL'NYY, I. A., Vologod Polytechnical Institute; Vologod Pedagogic Institute

[Abstract] Composite Al-B materials are presently made with various aluminum matrices, including AD33 alloy. This article presents results of studies of unidirectional fiber composite materials consisting of AD33 plus boron in low-cycle deformation with symmetrical pure flexure at 0.83 Hz in air and in 3% NaCl. Accumulated damage in the form of breakage of boron fibers, breakage of bonds between the matrix and the fibers, cracks, delamination, etc. were determined by the relative decrease in frequency of free oscillations of the system with a mass attached to one end of the specimen. It was established that under static loading the accumulation of damage amounts primarily to breakage of boron fibers, while under cyclic loading the damage is primarily breakage of bonds between fibers and matrix. One promising method of protecting Al-B composite from corrosive media in closed systems is shown to be corrosion inhibitors. The addition of 2% potassium chromate inhibitor significantly decreased the rate of accumulation of damage in the composite under practically all test conditions in NaCl. Figures 3; references 3: all Russian.
[013-6508]

UDC 539.4:678.067

DEVELOPMENT AND STUDY OF TWO-MATRIX GLASS FIBER COMPOSITE WITH INCREASED TRANSVERSE DEFORMATION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 28 Jun 83) pp 662-666

VASIL'YEV, V. V. and SALOV, V. A., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] Increasing the effectiveness and expanding the area of application of composite materials will require increasing of limiting deformation of unidirectional materials in transverse extension. It is possible even to decrease strength in this direction. The natural means of increasing transverse deformation is to increase the maximum deformation of the polymer binder. Increasing the deformation and decreasing Poisson's ratio of the binder allows production of a composite with the necessary transverse deformation. However, it is also necessary that the longitudinal strength remain at the level corresponding to the rigid binder. This can be achieved if the maximum deformation of the binder is no less than 60%, the mean value of Poisson's ratio is

on the order of 0.35 and the modulus of elasticity is at least 3 GPa. The solution suggested to this problem is based on separation of the function of one binder among two. In the first stage, glass fiber is saturated with a rigid binder and fully secured. In the second stage coils of these composite fibers are used to construct a material based on an elastic binder by the traditional method. In the three-component material thus produced the rigid binder supports joint work of monofilaments, the elastic binder provides the necessary transverse deformation of the unidirectional materials. Tests confirm the suitability of the method suggested. Figures 4; references 7: 6 Russian, 1 Western.
[023-6508]

UDC 620.17:678.067

TESTING OF WOUND MATERIALS FOR STRENGTH WITH LOADING IN THE REINFORCEMENT PLANE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 23 Apr 83) pp 713-718

NIKOLAYEV, V. P. and POPOV, V. D., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy; Central Scientific Research Institute of Shipbuilding Technology, Leningrad

[Abstract] Test specimens were cut from glass reinforced plastic cylinders with inside diameter 150 mm, thickness 12-14 mm, length 320 mm. The cylinders were obtained by winding with a fiber:binder ratio of 1:1. After the specimens were coated with a sealer, they were tested in compression in the circumferential direction in a hydrostatic chamber. The tests indicated that with specimen thickness less than 8 mm, loss of stability may occur. The fracture stresses for 8- and 10-mm specimens were found to depend little on strength. Specimens 4 and 6 mm thick were strength tested with reinforcing inserts to prevent loss of stability. The results indicated that use of these reinforcements allows more precise determination of the strength of wound material in compression and in shear in the plane of the reinforcement. References 7: all Russian.
[023-6508]

UDC 621.762.669.018.95

EFFECT OF PHASE STATE OF TiC-NiTi POWDER COMPOSITE MATERIALS ON NATURE OF FAILURE AND MECHANICAL PROPERTIES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84 (manuscript received 14 Jul 83) pp 88-92

KUL'KOV, S. N., POLETIKA, T. M., CHUKHLOMLIN, A. Yu. and PANIN, V. Ye., Institute of Optics of the Atmosphere, USSR Academy of Sciences

[Abstract] No studies have been made of the role of martensite conversions in forming mechanical properties or their impact on the phase state of TiC-NiTi

alloys. The present article addresses these mechanical properties as well as the contribution of the binder to the plasticity of the material after baking. The test alloys had 30-80% bonding phase by volume. They were tested for compression and bending, and examined by electron fractographic equipment. X-ray analysis showed that at compression loads above 678 MPa, deformation martensite appeared in the alloys, while in bending it appeared only on the fracture surface when NiTi content was 60%. The stoichiometric composition of the binder could be preserved and formation of an Ni_3Ti phase avoided during baking if titanium was added to the initial components. Calculations are presented for determining the amount needed. The coefficient of stress intensity was much higher for the NiC-NiTi alloys than for TiC- and WC-Co alloys, thus indicating heightened elastic properties for the test alloy. The addition of titanium holds the binder in the pre-martensite phase. Figures 6; references 4: 3 Russian, 1 Western.
[42-12131]

UDC 539.3.669.13

DISSIPATION OF ENERGY IN COMPOSITE MATERIAL

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 7 Dec 82) pp 92-94

ARKHIPOV, I. K., GOLOVIN, S. A. and PETRUSHIN, G. D., Tula Polytechnical Institute

[Abstract] An earlier work developed the theoretical curve of the amplitude variation of internal friction in composites considering the heterogeneity of the stress state and the structure of the material as well as the mechanical characteristics of the matrix and filler (gray cast iron with graphite filter). This article studies the relationship between stress and strain for uniaxial cyclical loading, assuming cyclical hardening of the matrix material. Analysis of the numerical results indicates that the theoretical model suggested for the behavior of composite materials satisfactorily describes the actual process of energy dissipation upon fluctuation of heterogeneous materials. The divergence between experimental and calculated internal scattering is explained by the influence of magnetoelastic effects appearing on cyclical deformation of ferromagnetic materials in the form of a maximum at high values of stress amplitudes. Figures 2; references 6: all Russian.
[005-6508]

UDC 539.216.1.669.71'781

DIVISION BOUNDARY IN Al-B COMPOSITE MATERIAL WITH BORON IN CONTACT WITH SOLID AND LIQUID ALUMINUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 84 pp 15-17

AREF'YEV, B. A., REBROV, A. V. and ZHURKOVA, T. B., Institute of Metallurgy imeni A. A. Baykov

[Abstract] The purpose of this work was to determine the influence of temperature and force factors on processes occurring at the fiber-matrix boundary in the production of an aluminum-boron composite material. The division boundary in the composite, obtained by rolling of a batch of monolayers of matrix and reinforcing material and in specimens produced by soaking a bundle of fibers in liquid metal, was studied. During rolling, spinels $2Al_2O_3 \cdot B_2O_3$, $9Al_2O_3 \cdot B_2O_3$ and an AlB_{12} phase are formed, growing as isolated inclusions in the depth of the fibers and leading to loss of strength. During heat treatment, the phase AlB_2 was found at the spinel-matrix boundary, though it did not significantly influence fiber strength. Upon liquid phase saturation, the phase AlB_2 is formed in an actual composite material with an unalloyed matrix, decreasing fiber strength, while alloying of the matrix with magnesium decreases the quantity of interaction products and changes the phase composition of the transition zone. Figures 1; references 5: 4 Russian, 1 Western.
[001-6508]

UDC 539.216.1:669.71'781

ESTIMATING DEGREE OF DEVELOPMENT OF PHYSICAL-CHEMICAL INTERACTION AMONG COMPONENTS IN Al-B FIBER COMPOSITE MATERIAL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 84 pp 11-15

SHORSHOROV, M. Kh., KOLESNICHENKO, V. A. and KOCHESHKOV, I. V., Institute of Metallurgy imeni A. A. Baykov

[Abstract] An analysis is presented of possible means of solving the problem of the influence of degree of development of physical and chemical interactions at the fiber-matrix division boundary on the strength characteristics of Al-B composite materials. The most promising method of estimating the degree of development of physical-chemical interaction between components of the composite based on results of shear strength testing of the material is discussed. The method of estimating the degree of physical-chemical interaction based on the relative bonding strength of the fibers with the matrix is simple and provides reliable results. The relative strength can be used to estimate the degree of physical-chemical interaction between fibers and matrix only if there are no intermetallide compounds in the area of interaction. Figures 5; references 8: all Russian.
[001-6508]

UDC 620.192.43:669.71'782'784

SEGREGATION OF SILICON IN SILUMIN-CARBON FIBER COMPOSITES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 84 pp 24-26

CHERNYSHOVA, T. A., KOBELEVA, L. I., TYLKINA, M. I. and REBROV, A. A., Institute of Metallurgy imeni A. A. Baykov

[Abstract] A study is presented of the reaction products at the interphase boundary in composites of Al or the alloy Al2 containing about 12% Si and type LU carbon belt. Studies were performed on specimens produced by vacuum-compression saturation of the belt with the melt as well as model specimens using 40 μm diameter carbon monofibers. Microstructure was studied on a microscope, distribution of elements in specimens with a microanalyzer, interaction products at the interphase boundary by electron microscope examination of extraction carbon replicas. Crystals of silicon carbide and primary crystals of silicon are observed on the surface of carbon fibers in the composites, which means that the total content of aluminum carbide in the composite is decreased. Figures 1; references 11: 9 Russian, 2 Western.
[001-6508]

UDC 669.3'293'784

POSSIBILITY OF PRODUCING MONOLITHIC COMPOSITE MATERIALS BASED ON NIOBIUM CARBIDE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 8, Aug 84 pp 26-27

PLOSHKIN, V. V., UL'YANINA, I. Yu. and FILONENKO, V.P., Metal Products Plant at ZIL Motor Vehicle Plant

[Abstract] An attempt is made to create a composite material based on niobium carbide with good heat resistance, erosion and chemical stability in special media, capable of withstanding great thermal shock. The initial material used was a powder of niobium carbide with particle size less than 10 μm; the binder consisted of particles of pure copper in the 10-12 μm fraction, which sublimates upon thermal shock and helps to decrease the temperature of parts. Copper also does not interact with niobium carbide under any conditions. The niobium carbide-copper compsite was manufatured by the high-pressure method. Sintering under high pressure produced practically monolithic composites with minimal porosity. The structure of the specimens produced was studied by light and scanning electron microscopy. The major phases were uniformly distributed through the specimens and did not interact with each other. The composite material has good thermal shock resistance and is not subject to brittle fracture as are materials of this type produced by other methods. Figures 2; references 4: all Russian.
[001-6508]

CONFERENCE ON STRUCTURAL MATERIALS FOR THERMONUCLEAR REACTORS

Leningrad LENINGRADSKAYA PRAVDA in Russian 23 Nov 84 p 3

[Text] Participants in the All-Union Conference on Research and Development of Structural Materials for Thermonuclear Fusion Reactors examined models of thermonuclear units which are prototypes of inexhaustible energy sources of the next century. This was the third of these representative meetings of specialists in this field, which traditionally are convened in Leningrad by the USSR Academy of Sciences and the USSR State Committee on the Use of Atomic Energy. Taking part in the conference's work were representatives of leading research centers of our country, as well as specialists from Bulgaria, Hungary, the German Democratic Republic and Czechoslovakia, and a group of Euratom associates from the Joint Scientific Research Center in Ispra (Italy).

Commenting on the conference's results, Professor L. I. Ivanov, chairman of the Coordinating Council of the USSR Academy of Sciences, said: "The development of new types of energy is the ultimate goal of active work on the development of 'TOKAMAK' and other types of thermonuclear reactors which is in progress both in our country and abroad. In the first place this work involves the development of fundamentally new types of materials for equipment which will have to operate in the extremely rigorous conditions of superhigh temperatures (on the order of tens of millions of degrees), high vacuum and unprecedented radiation loads. Papers presented at the conference by Soviet participants demonstrated that we are close to developing such materials. This will speed the accomplishment of the task of building the first demonstration reactors and subsequently experimental thermonuclear power plants by the end of the century.

"Foreign guests at the conference had high praise for the achievements of Soviet scientists and specialists, and for the prospects of international cooperation in accomplishing one of the main scientific and technical tasks of our time.

"The conference summed up results and outlined promising directions in the field of development of structural materials for thermonuclear fusion reactors."

FTD/SNAP
CSO: 1842/50

UDC 533.92:535.35

ADEQUACY OF METAL ABLATION PROCESS WITH LASER RADIATION AND A SHOCK-COMPRESSED PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 10 Oct 82) pp 35-38

SULTANOV, M. A., Dushanbe

[Abstract] Mechanisms of interaction of a shock-compressed plasma and laser radiation with various metals are compared. It is noted that the origin of the radiation is not significant in the process of ablation of metals. When a supersonic plasma stream strikes a flat solid metal obstacle, a shock-compressed plasma is formed, in which radiation is greatly retarded due to the collisions among electrons and ions. In the quasisteady laser mode used in this work there are many peaks, the intensity and number of which decrease during the course of radiation. The unsteadiness of the process results from the nature of operation of the laser and heterogeneous distribution of light radiation intensity. When laser radiation and a moderate density plasma interact with metals the mechanism of destruction of the metals is somewhat similar. In both cases the process of interaction is accompanied by gas dynamic effects. The mechanism of ablation of metals under the influence of radiation is thermal in nature. Figures 2; references 8: all Russian. [002-6508]

UDC 535.211

BREAKDOWN OF THIN PLATES BY RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 84 (manuscript received 21 Jul 82) pp 9-11

AGEYEV, V. P., ISAKOV, M. V., MARTYNOV, V. A., MOROZOV, V. V. and CHERNOMORDIK, V. V., Moscow

[Abstract] Heating of thermally thin plates by radiation till breakdown of the material during air blast or natural convection is analyzed phenomenologically, a thin plate being one with a temperature drop across the thickness

much smaller than the mean temperature rise. The equation of heat balance $dT/dt = (I_{ab}-I_{em}-I_{conv})/c_p\rho h$ (T- temperature, t- time, I_{ab}- intensity of heat absorption, I_{em}- intensity of heat emission, c_p- specific heat of material, ρ- density of material, h- thickness of plate) is solved for two possible kinds of such plates. In the case of optically transparent materials with $\alpha h \ll 1$ (α - absorption coefficient) heating is determined principally by absorption of radiation in the volume and $I_{ab}=I_{in}(1- R)(1- e^{-\alpha h})$ (I_{in}- intensity of incident radiation, R- reflection coefficient). In the case of materials such as metals with high thermal conductivity and $h^2/4\pi\chi \ll \tau$ (χ - thermal diffusivity, τ - duration of surface heat source) $I_{ab}= I_{in}$ (1- R). In both cases $I_{em}= 2\sigma\varepsilon (T^4 - T_0^4)$ (σ - Stefan constant, ε - emissivity, T_0 - ambient temperature) and the intensity of heat dissipation by convection is $I_{conv}=H_\Sigma(T- T_0)$ (H_Σ - convection coefficient depending on convection at both sides of the plate and on plate orientation in space). The equation can be solved for the threshold intensity of incident radiation which will break down the material at any temperature. With application of the mean-value theorem and linear approximation of the exponent in the relation for total incident radiation energy $I_{in}\tau$, numerical calculations were made for polyethylene and polyethylene terephthalate (Mylar) films as well as for aluminum foils. The formulas used here are sufficiently simple and accurate for engineering purposes so as not to require numerical solution on a computer. Figures 2; references 4: 3 Russian, 1 Western (in Russian translation).
[36-2415]

UDC 678.011

THEORY OF RELAXATION PROCESSES IN DECOMPOSING POLYMER MATERIALS DURING HIGH-INTENSITY CONVECTIVE HEATING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 5, Oct 84 (manuscript received 23 Jan 84) pp 1112-1115

ISAKOV, G. N., NESMELOV, V. V., VISHNEVSKIY, G. Ye. and ZADORINA, Ye. N., Scientific Research Institute of Applied Mathematics and Mechanics, Tomsk State University imeni V. V. Kuybyshev; Moscow Aviation Institute imeni S. Ordzhonikidze

[Abstract] An understanding of a polymer as a complex system containing several sub-systems in weak interaction with each other has helped in determining the processes involved in thermal destruction of such a polymer. The present article reports on a mathematical description of thermal destruction during convective heating with approximation of constant coefficients of transfer. Mathematical calculations and resulting formulas are presented. Parameters generated indicate that thermal failure takes place in a predictable temperature range which holds for a given sub-system. The relaxational nature of polymer breakdown during high-speed heating in a gas medium is confirmed. Figures 1; references 12: all Russian.
[41-12131]

UDC 535.211:539.371

THERMOELASTIC STRESSES IN A DISK HEATED BY LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 26 Apr 82) pp 111-114

TIMAN, B. L. and FESENKO, V. M., Khar'kov

[Abstract] Thermoelastic stresses are calculated in a disk heated by laser radiation. Graphs of thermoelectric stresses in the disk are constructed. The results obtained can be used to determine conditions under which a specimen is fractured by a laser beam. Figures 2; references 5: 4 Russian, 1 Western.
[002-6508]

UDC 534.613+621.373.029

EFFECT OF TRANSPARENT COATINGS ON GENERATION OF LASER-INDUCED SHOCK WAVES IN METALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 84 (manuscript received 27 Sep 82) pp 29-33

ZHIRYAKOV, B. M. and OBESNYUK, V. F., Moscow

[Abstract] An experimental study with a Q-switched laser generating short pressure pulses for surface treatment of metals was made, of particular interest being measurement of pressure near the interaction epicenter with instruments more precise than a conventional piezoelectric quartz crystal. A ruby laser emitting pulses of 0.5 J energy and 25 ns duration was used for this purpose with an SFR-1M camera for high-speed photographic recording, including exposure control and synchronization. The laser beam was focused onto a spot 0.8-0.9 mm in diameter on the surface of target metals, calibrated light filters regulating the radiant flux intensity up to a maximum of $5 \cdot 10^9$ W/cm^2. Foils and slabs of copper, brass, and aluminum were used as targets, their polished surfaces being covered with a dielectric liquid (distilled water or machine oil). A thin, strongly absorbing opaque layer formed at the metal-dielectric interface under impact of a giant radiation pulse and expanded rapidly during as well as after that pulse. One experiment measured the propagation of the shock wavefront, its velocity having been found to decrease from an initial $4.6\ 10^3$ m/s or higher in the opaque medium to $1.54 \cdot 10^3$ m/s approaching the acoustic velocity in the liquid with the latter remaining transparent under pressures up to 14.4 GPa. In another experiment a layer of liquid was placed on the metal surface covering an area much larger than just the light spot. Its thickness was varied, for measurement of the rate of its dispersal by laser-induced shock waves and of the pressure at the interaction epicenter as functions of the radiant flux intensity and of the distance traveled by the shock wave. The experimental data correlate with theoretical

calculations based on thermodynamics of shock waves and on heat balance, the mixture of dielectric liquid/vapor and metal vapor being quite accurately describable by the equation of state for an ideal gas. The results also agree closely with those of similar experiments with a neodymium-glass laser. Figures 5; references 13: 7 Russian, 6 Western.
[36-2415]

UDC 669.2/8;539.2

DECOMPOSITION OF VTAN ALLOY SOLID SOLUTION UPON IRRADIATION AND THERMAL AGING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 12 Jun 84) pp 27-30

IVANOV, L. I., LAZORENKO, V. M., PLATOV, Yu. M. and SIMAKOV, S. V., Moscow

[Abstract] The alloy VTAN (VTiNbN) is a dispersion hardened alloy which retains good mechanical properties up to 800°C. This article presents results of electron microscope studies of the structures of VTAN after various types of thermal and radiation aging. Specimens were preliminarily vacuum annealed and cooled at about 1°C/second. It is found that the good mechanical properties of this alloy are related not only to the presence of a TiN crystallization phase, but also the presence of a finely dispersed Ti(Nb,V)N phase formed during aging. Bombardment with 1 MeV electrons at $6 \cdot 10^{12}$ $cm^{-2} \cdot s^{-1}$ decreases the temperature at which the alloy begins to decompose by approximately 500°C. Decomposition of the alloy upon bombardment is accompanied by the formation of a modulated structure not observed with thermal aging. Figures 3; references 8: 6 Russian, 2 Western.
[002-6508]

FERROUS METALLURGY

METALLURGISTS ASKED TO RAISE RESPONSIBILITY, DISCIPLINE

Kiev PRAVDA UKRAINY in Russian 21 Oct 84 p 2

[Article by B. Kachura, member of the Politburo and secretary of the Ukrainian CP Central Committee: "Raise Responsibility and Strengthen Discipline in the Collectives of the Metallurgists"]

[Text] In all stages of communist construction, the CPSU Central Committee and the Soviet Government have attached and are attaching primary importance to the development of ferrous metallurgy and to increased output and improved quality of metal products. In his speech at a meeting with metallurgists of the Moscow plant "Sickle and Hammer," K.U. Chernenko, general secretary of the CPSU Central Committee and chairman of the USSR Supreme Soviet Presidium, stressed the necessity of accelerating the technical retooling of metallurgical production, of very rapidly introducing the latest achievements of science and advanced experience, of increasing the rate of renewal of fixed production capital, of shortening the time for the assimilation of the planning indicators of newly introduced production processes and machine units, and of compensating for expended resources. "Here," emphasized Konstantin Ustinovich," we consider the main thing to be a consistent increase in the output of high-quality and economical metal production. Otherwise, it is impossible to achieve the required turning point in machine building, construction and other sectors."

The republic's metallurgists understand very well that it is possible to be successful in coping with the established tasks only when each labor collective has strong discipline, a clear and well-managed organization of production and labor, and high responsibility by those performing the tasks. And they are doing quite a lot in this direction. The decisions of the February and April (1984) CPSU Central Committee plenums and the Law on Labor Collectives were a powerful impulse in the work of party committees, trade-union and Komsomol organizations, and economic managers to strengthen socialist discipline and to raise the responsibility of personnel.

The strengthening of organizational and mass-political work in the collectives, the increase in the engineering and technical level of production, and the elimination of "bottlenecks" in a number of enterprises of the ore-extracting, coke and chemical and refractory industry made it possible to stabilize the situation somewhat at metallurgical combines and plants. A noticeable increase in the output of metal has been achieved in the last 2 years. For the first 9 months of this year, the plan has been fulfilled for most basic types of

metal production, the above-plan increase in labor productivity amounted to 1.6 percent, and profits were R30 million above the plan.

The party committee of the Makeyevka Metallurgical Combine imeni S.M. Kirov is skillfully influencing the life and work of the collective. It was not long ago that the combine was among those lagging behind. It was hindered by the lack of discipline of some workers, the low responsibility of executors, and the weak influence of the collective on the indifferent workers, on those who preferred to work less and receive more. The goal set by the enterprise party committee for the communists and the entire collective was to eliminate these shortcomings, raise discipline in all production sections, and make their work smooth and accurate.

The party committee and the shop party organizations shifted the focus of their work to the brigades. The placed communists so that their influence would cover each section. Party groups were organized by shifts, and where there were not enough communists for this they approved party organizers. Everyone was responsible for the strictest observance of internal order and the entire collective took an interest in this. They judged both the person violating discipline and the person protecting the violator. The level of discipline was evaluated by the results of the fulfillment of planning tasks.

They then decided to include the fulfillment of orders among the evaluation indicators. The collective adopted a counterplan to fulfill an additional party task to raise labor productivity and lower the cost of production. At visible places in the rooms for shift meetings, they hung charts for the basic tasks of the collective and the dynamics of their implementation. For example, how much cast iron or steel must the brigade produce in a day, week or month, how much iron alloy, fuel and energy is needed to do it, where and how much can be saved, and what has actually been accomplished. The workers themselves maintain order and strive to work conscientiously.

And the results were not bad. Since the beginning of the year, 25,000 tons of cast iron, 38,000 tons of steel and 22,000 tons of rolled metal have been produced above the plan. The combine's steelworkers are putting out all of their production exactly as called for in the orders. The above-plan increase in labor productivity was 2.6 percent and the cost of production was lowered by 0.8 percent beyond the target.

The high level of discipline and organization and the self-sacrificing labor of workers, engineers and technicians are helping the collective of Donetsk Metallurgical Plant to resolve production tasks successfully. Discipline here is organically linked with the fulfillment of the output norms and planning tasks and with the active participation of the workers in scientific and technical creativity. At the initiative of communist workers supported by the party committee, they have set the course for the broad incorporation of advanced experience, new equipment and progressive technology. All of this has ensured for this year the production of 1,600 tons of steel, 5,500 tons of cast iron and 8,700 tons of rolled metal above the plan. Donetsk metallurgists were among the first in the country to introduce the pouring of steel from founder's scoops equipped with sliding catches. The economic effect exceeded R150,000 annually. In the electrical smelting shop, they introduced a vacuum installation for the processing of steel outside of furnaces, which not only

improves the quality of the metal but also greatly reduces the time of the smelting. Scientists of the Moscow Institute of Steel and Alloys, DonNIIchermeta [Donetsk Scientific Research Institute for Ferrous Metallurgy], Kiev Institute of Automation, and several other scientific research organizations are actively helping the plant workers to introduce technical innovations.

A high level of organization and strong discipline characterize the labor collectives of the Dneprovskiy imeni Dzerzhinskiy and Kommunarsk metallurgical combines, the Novomoskovsk pipe and Yasinovskiy coke and chemical plants, the Ingulets and Ordzhonikidze mining and enrichment combines, the mining management imeni Kirov of the association "Krivbassruda" and several other sector enterprises, which are successfully fulfilling the plans and the accepted socialist obligations.

Working at the enterprises of nonferrous metallurgy today is a large group of party-trained outstanding masters of the fiery occupation and illustrious metallurgists, leading workers and production innovators. Included are G.Ya. Gorban', two-time Hero of Socialist Labor; Heroes of Socialist Labor V.N. Marchenko, V.A. Orlov, D.N. Ovcharenko, P.E. Gil', and V.N. Dovgan'; S.V. Chernyy, deputy to the USSR Supreme Soviet; and many others. They are all characterized by a spirit of discipline, by being well organized personally, and by exceptionally high responsibility for the assigned work, the fate of the collective, and its authority. They are demanding of themselves, are always ready to help their comrades, whatever the time, and they do much public work. Their experience is of great value to us and should be used fully by each labor collective.

A study of the situation in ferrous metallurgy in the republic shows that certain positive changes have been noted in this sector. But only the first steps have been taken so far. A number of combines and plants are still working with interruptions, are not fulfilling the established plans, and are lowering the volume of metal production. The combine "Zaporozhstal'" and the Yenakiyevo Metallurgical Plant lagged far behind in all of metallurgical reprocessing this year. The Bagleyskiy, Krivorozhskiy, Dneprodzerzhinsk and Avdeyevka coke and chemical plants and the Northern Mining and Enrichment Combine are working unsteadily.

It is clear that to a certain extent the backwardness in the work of the indicated enterprises can be explained by a number of objective factors. However, a detailed analysis shows that at most of them labor and technological discipline is still low, the required demands are not being put on the executors, the role of the labor collective is diminished, and there is no clear coordination of the work of economic managers and public organizations. Little is being done here to use internal economic reserves to improve production work.

Perhaps there is not a single meeting of the ministry staff and not a single conference where they do not talk about the necessity of strengthening discipline, of preventing breakdowns, and of reducing above-plan downtime for basic metallurgical machine units. And quite a lot has been done recently in this direction. Positive changes have been made, but they are far from the changes envisioned when the national economic plans were worked out. And this is mainly related to a lack of discipline and frequently to the lack of conscience

of some workers. In the sector as a whole, current downtime of blast furnaces, steel smelting machines and rolled-metal mills significantly exceeded what was planned. For this reason, losses in the production of cast iron, steel and rolled metal amount to hundreds of thousands of tons.

Party committees and economic managers must draw the necessary conclusions from this and they must put higher demands above all on the managing employees and the engineering and technical personnel as the organizers of production, transmitters of technical progress and teachers of the workers to maintain a state of order and organization. Emphasis should be put on the broad application of collective forms of organizing and paying for labor according to final results and on the general introduction of contract and cost-accounting brigades with the use of the coefficient of labor participation. And this is precisely where things are not going well in the enterprises of the Ukrainian SSR Ministry of Ferrous Metallurgy.

In accordance with the demands of the December (1983) and February and April (1984) CPSU Central Committee plenums, the economic managers and party organizations of the enterprises of ferrous metallurgy took a number of measures to strengthen planning discipline and to ensure the timely and complete fulfillment of contractual obligations to deliver output to consumers. A certain amount of work has been done to get metallurgical enterprises to plan the production of rolled metal according to the developed assortment with consideration given to its labor-intensiveness and degree of economy, and this has created better conditions for fulfilling orders and for increasing the initiative and motivation of collectives to produce an effective output of metals.

Positive results have been achieved at the Kramatorsk and Konstantinovka metallurgical plants, at the Novomoskovsk and Khartsyzsk pipe plants and at several other enterprises. The level of fulfillment of contractual obligations increased overall for the Ukrainian SSR Ministry of Ferrous Metallurgy. For the first 9 months of this year, deliveries of finished rolled metal were made in full to some very important consumers--the agroindustrial complex, the construction organizations, the Ukrainian SSR Ministry of the Coal Industry, and the Ukrainian SSR Ministry of Local Industry.

At some plants, nevertheless, contractual obligations for deliveries are not being met and channels for the production of unordered output and output that is not in demand have not been completely stopped. In the current year, with an overfulfillment of the planned output of finished rolled metal in the sector by 62,000 tons, consumers came up short by 510,000 tons on issued supply orders. At the same time, 248,000 tons of unordered metal was shipped. There are also serious violations in intrasectorial shipments, which disorganizes the work of individual enterprises of ferrous metallurgy.

To a large extent, the nonfulfillment of contractual obligations to deliver metal to consumers is explained by the lack of a spirit of discipline on the part of individual managers and by their striving to ensure the fulfillment of production plans without considering the interests of the customers. Party committees and enterprise managers must analyze in more depth the situation with respect to the fulfillment of shipment plans, they must improve the

competition of the work collectives according to the principle of the "work race," and they must call to account in a party manner those who are at fault in the violation of contractual obligations.

There is still another problem to whose resolution the party assigns urgent importance and which must be the focus of attention of the sector managers and all communists. That is the problem of saving metal and other material resources. More metal is smelted in our country than in any other. But this does not mean that it can be used up any way one wants to. There are two basic directions for the rational utilization of metal. One is to improve its quality and increase the output of economic types of metal production, and the other is to the lower the use of metal in the sector itself and at the consumers. Some achievements are evident here. Thus, during the years of the 11th Five-Year Plan, 11 new brands of steel and 78 profiles of rolled metal were developed in the republic. The production of economical kinds of rolled metal, tubing and metal products increased by 3 million tons, or by 15 percent. The output of production with the State Emblem of Quality was increased to 20 percent.

But there are other figures. This year, there was an indebtedness in the production of low-alloy steel, in heat-tempered rolled metal, and in cold-rolled sheet metal. This is the reason for the numerous complaints of consumers and for the insufficient reliability and durability of some machines and equipment. And the task that has been set is not a simple one: just according to the republic's complex special program "Metal," not less than 2 million tons of rolled steel is to be saved during the five-year plan. This is possible only under the condition that party organizations will more actively involve scientific forces, production collectives, designers, efficiency experts and inventors in its resolution.

It is very important to make each manager and specialist and each worker aware of the fact that the growing requirements of the national economy for metal, fuel, energy, raw materials and other materials must more and more be satisfied not by consuming more of them but by reducing relative expenditures and losses.

The question of questions involves the technical retooling of enterprises and the introduction of the latest achievements of science and advanced experience. And of primary importance here are responsibility and discipline. At the enterprises of ferrous metallurgy in the republic, much has been done in the construction of new and the reconstruction and modernization of existing machine units, shops and production systems, as well as in the incorporation of new techniques and progressive technology. Since the beginning of the five-year plan, more than R4 billion in capital investments have been assimilated. They have introduced new capacities for the extraction of iron and manganese ore, an oxidizing-converter shop with a combined compressed-air system at the Dneprovskiy Metallurgical Combine imeni Dzerzhinskiy, the first line of a thick-sheet mill at "3000" at the Zhdanov Combine imeni Il'yich, two electric furnaces with a machine for the continuous pouring of ingots at Donetsk Metallurgical Plant, and a number of other installations. There was an increase in the volume of capital repairs, with the reconstruction of basic metallurgical machine units and the relaying of coking batteries.

Worthy of attention is the positive experience of the combine "Krivorozhstal'," where practically every major repair of machine units and shops was carried out with the reconstruction or modernization of equipment. In a very short time here, extensive work was done on three blast furnaces, the most highly efficient No 2 bloomery, and five rolling mills. This had a significant economic effect, making it possible to lower the relative expenditures for iron ore raw material and coke and to double the output of production with the Emblem of Quality.

Nevertheless, everything possible has not been done. The allocated capital investments for the development and technical retooling of the sector are not being used as they should be. Last year, for example, R43 million were not fully assimilated. The deadlines were not met for putting the department for thermal hardening of rails at Azovstal' Combine into operation, and there has been a delay in the construction of installations for the production of molded coke at the Bagleyskiy Coke and Chemical Plant and briquettes at the Northern Mining and Enrichment Combine.

To a large extent, the technical retooling of ferrous metallurgy, its further development and improvement, and increased efficiency in the sector depend upon the skill level of personnel and upon their spirit of discipline and ability to organize and manage modern production accurately. Together with the obkoms, gorkoms and raykoms, the Ukrainian SSR Ministry of Ferrous Metallurgy has implemented a number of measures to strengthen the management of many enterprises and to improve the quality of the staff of directors of shops and sections and of senior foremen and foremen. As a whole, there are now more young workers in metallurgy and turnover has declined.

But the party committees and the management of the Zaporozhstal' Combine, the Kriborozhskiy Coke and Chemical Plant, and the Poltava Mining and Enrichment Combine are still insufficiently objective in dealing with personnel. Here they have not created an effective reserve of highly qualified personnel, and the result is that a number of important production sections are headed by poorly trained, unenterprising and often undisciplined workers, and some of the positions of leading specialists and service managers remain vacant for a long time. Not everywhere is the technical training of engineering and technical personnel organized as it should be, and their certification is carried out as a matter of form. There are also substantial shortcomings in the work with young specialists.

At a number of sector enterprises, the proper attention is not being paid to increasing the responsibility of managers and specialists for the assigned section and for strict observance of state, planning and financial discipline. There are cases of deception, mismanagement, waste and the misuse of one's official position. This year there were violations of staff discipline at the Kommunarsk and Zhdanov imeni Il'yich metallurgical combines. Cases have been ascertained of gross violation of financial discipline, waste and misuse of official positions at the Poltava Mining and Enrichment Combine at the enterprise "Krivbassvzryvprom."

In its decree on improving the selection, distribution and education of sector personnel, the Ukrainian CP Central Committee has drawn the attention of the

managers of the Ukrainian SSR Ministry of Ferrous Metallurgy to these shortcomings. Measures are being taken at the sites to eliminate shortcomings in the work of personnel. But attention to the questions must not be relaxed.

Everywhere the efforts of the collectives are now directed toward the formation of plans for social and economic development for the 12th Five-Year Plan and through the year 2000. Party organizations and the managers of the enterprises and organizations of ferrous metallurgy must involve themselves more energetically in this work and they must attain the active participation of the workers in revealing and utilizing the internal reserves in each labor collective and at each workplace, remembering that the most important task of the party is comprehensive intensification of production, improved quality and a reduction in the cost of production. It is a matter of honor for the republic's metallurgists to implement the tasks set by the party and to receive the 27th CPSU Congress in a worthy manner.

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INFLUENCE OF LASER TREATMENT OF STRUCTURE AND MECHANICAL PROPERTIES OF MA21 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, Sep 84 pp 31-34

KALIMULLIN, R. Kh., KOZHEVNIKOV, Yu. Ya., FAYZULLIN, I. Ya., VALUYEV, V. V., Urals Motor Vehicle Plant

[Abstract] An attempt was made to use very rapid heating and cooling obtained by laser surface heat treatment to increase the strength of cast magnesium alloy MA21 containing about 8% Li, 5% Al, 4% Cd, 1% Zn and 0.4% Mn. Test specimens were irradiated in the hot pressed state by a continuous CO_2 laser and a pulsed laser. The microstructure of these alloys was studied on an optical microscope, fractographic analysis of specimens performed on an electron microscope by a two-step replica method. Mechanical testing, visual examination of specimens and measurement of microhardness indicated that the strength properties of the alloy were improved by laser treatment due to the formation of a hardened layer on the surface of the specimen. Ductility is reduced. The structure of the surface layer after laser treatment features fine grains and uniform distribution of phases through the volume. Figures 4; references 5: all Russian.
[011-6508]

UDC 669.14.018.252.3:621.3.038.8:621.78

SPECIFICS OF LASER HEAT TREATMENT OF HIGH SPEED STEEL TOOLS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, Sep 84 pp 25-28

D'YACHENKO, V. S., TVERDOKHLEBOV, G. N. and KOROSTELEVA, A. A., Khar'kov Aviation Institute imeni N. Ye. Zhukovskiy

[Abstract] A study is made of the influence of laser radiation pulse power densities on the structure, hardness and wear resistance of high speed steel. Experiments were performed on plates of R9K5 steel following standard heat

treatment, hardening and triple tempering at 550°C. The cutting tips of the specimens were irradiated on the back face by laser pulses of various strengths, each cutting tip irradiated with a single pulse. The structure and microhardness were studied in the immediate vicinity of the cutting edge. The results indicate that depending on power density W_p, laser heat treatment may increase or decrease wear resistance. Positive results are achieved after treatment with a pulse with a powerdensity which must be experimentally determined in each case. The optimal power must be selected from the structure of the steel, which should be a martensite-carbide mixture formed as a result of secondary hardening under the influence of the laser pulse. Figures 1; references 12: all Russian.
[011-6508]

STATUS OF UDOKAN COPPER DEPOSITS REVIEWED

Moscow IZVESTIYA in Russian 14 Sep 84 p 2

[Article by the IZVESTIYA editorial staff visiting the BAM: "Hour of Udokan"]

[Text] Just a few days remain before the joining of the Baykal-Amur Main Highway [BAM].

It will take place in the north of Chita Oblast, not far from the place where in the late 1940's the Irkutsk geologist Ye. I. Burova opened up the Udokan copper ore deposits, the largest in our country. The laying of the railroad here will doubtless become a turning point in the assimilation of this raw materials region, which up until now had been practically inaccessible for construction of any significant scale.

The fact is that the production cost of transporting cargo from Chita to Chara, the nearest settlement to Udokan, was more expensive than shipment to Norilsk or Magadan, for example. It is no accident that of the 20 variants of the railroad line, the closest to Udokan was selected through this very high-mountain section of the BAM.

Two years ago, the USSR Ministry of Nonferrous Metallurgy accepted the Udokan deposits for industrial development. At that time, they selected the spots for the main projects of an ore-enrichment combine and town.

How do things stand now?

Harsh and majestic are these cold-gray barren mountains, almost daily covered by rising and swirling clouds. There is something mysterious and enchanting in their wild and somber beauty that simultaneously frightens and beckons.

But here is the famous copper mountain, or, more accurately, a mountain whose upper part appears to have been placed on a gigantic dish of coppery sandstone. From a distance, it is no different from the neighboring barren mountains, but as you come closer, you see some small houses at its base among the stunted larches and swamp moss.

This is one of the worker settlements of the Udokan expedition for geological exploration. From the settlement, one can make out on the slope the entrance to a mining tunnel that leads into the copper ore. The tunnel was also opened up by the expedition. Yes, the geologists did some great work here. They studied Udokan not only from the surface but they also went through the mountain in exploratory tunnels, the total length of which is many dozens of kilometers. They processed thousands of tons of ore at laboratory and semiindustrial facilities. But for the time being, unfortunately, this is all that has been done at the unique deposit.

You will ask what was done at Udokan by the department that took over the deposit for exploitation. We answer: still nothing. The Ministry of Nonferrous Metals is in no hurry to establish itself on the open spaces along the BAM, even though the geologists are absolutely beckoning it with more and more new discoveries in the Kodaro-Udokan Mountain Region.

During the last decade, the Unkurskoye, Chineyskoye and Pravoingamakitskoye copper deposits have been opened up here, as has the Katuginskoye deposit that is rich in copper and rare metals, where, by the way, they found natural cryolite, which is very rare on the planet. All of this raises the national economic significance of Udokan, which promises to become a base for the assimilation of other sources of raw materials in the region. It is not without reason that a special subprogram "Copper Ore of Udokan" is included in the overall program "Siberia" worked out by the scientists of the Siberian branch of the USSR Academy of Sciences, and the problems of its realization are being studied in dozens of research institutes.

"The density of the reserves of minerals around Udokan has been determined to be even greater than in the Urals," noted academician A.G. Aganbegyan. "In addition, other than the Neryungri Raw Materials Complex in the BAM zone, there is no other region with such a high degree of preparedness for industrial development as the ore-producing Udokan."

Then why has this long-awaited industrial development not been started? For the technical and economic justification for the construction for the mining and enrichment combine was long ago worked out and has long since become obsolete. Two projects for a future miners' town have long been gathering dust in the files. The time for the introduction of the experimental industrial factory at the immediate site of the deposit has long since passed, and no one has come to build it. Is the only reason for this lack of urgency the lack of a railroad line?

Here is the opinion of M.I. Matagonov, first secretary of the Chita party obkom and deputy to the USSR Supreme Soviet, expressed in a conversation with us: "At one time, the Ministry of Nonferrous Metals had rather strong arguments not to be in a hurry about Udokan. In the 1960's, along with Norilsk, they opened up the large Talnakh Deposit--large-scale mines are now operating there--and the powerful Nadezhdinskiy Combine. In addition, while they were arguing and talking about Udokan, the Dzhezkazgan and a number of copper-ore combines in the Urals were reconstructed. This permitted the sector to increase production and, to some degree, to make less pressing the question of copper and,

along with it, the question of the development of Udokan, which required large capital investments."

As Mikhail Ivanovich sees it, the situation is now quite different. A railroad has been built to the previously inaccessible region. That is one thing. Another is that the market conditions for copper have become more difficult. Throughout the world, one is seeing a reduction in the metal content of ore, which forces one to work poorer deposits. The forecasts of specialists for the next decade are not very encouraging. It is therefore necessary to begin the industrial development of Udokan without delay, knowing that at least 10 years of hard work will be needed to receive the first concentrate here.

"We assume that this is all true," the metallurgical specialists say to us, "but we cannot fail to consider the fact that in an analysis under industrial conditions, the Udokan ore did not confirm the qualitative data on purity that the geologists were talking about."

Well, the question of the quality of the Udokan ore is not new, but, in raising it, some people prefer to keep silent about one very important circumstance.

We mentioned that at Udokan they were to build an experimental industrial factory--sort of a miniature GOK [mining and enrichment combine]. Such an enterprise is extremely necessary so that here, on site, precisely under the specific conditions of the deposit, they can select and work out the most appropriate model for enriching the local ores. The fact is that this is the first time that the sector has encountered such ores, and there is no ready and tested technology for their processing. The Ministry of Nonferrous Metals was allocated no less than R98 million for the experimental factory, and its construction was assigned to the organizations of the Ministry of Industrial Construction, the Ministry of Transport Construction and the Ministry of Power and Electrification, which have large subdivisions in the Transbaykal Region. But things went no further than talks, which, by the way, did not disturb the customer very much. They decided to analyze the Udokan ore in faraway Ryazan and Sherlovaya Gora. No one considered thereby that the semi-oxidized samples will oxidize further on the way there, that they are not at all using the same water for the tests that is found underground at the deposit, and that the qualitative indicators of the ore will automatically fall and will differ markedly from the true indicators, and this, in turn, will lead to erroneous initial data for the planning work and the forecasting of the economic efficiency of the future mining and enrichment combine. F.P. Krendelev, doctor of geological-mineralogical sciences and head of the recently established Institute of Natural Resources of the Siberian branch of the USSR Academy of Sciences, for whose collective Udokan is a principal research project, spoke to us about this with understandable concern.

And here is what we again thought about when we visited this institute. The scientists, party and soviet workers and economic managers--in a word, all of those who are studying the problems of Udokan in depth and in a responsible way, who are not closing their eyes to the fact that this deposit must be developed whether one wants to or not, and not sometime later but in the very near future, and who, finally, are not indifferent to what price must be paid

here for each ton of red metal--all consider that today the question of questions is the necessity for the accelerated construction of the experimental industrial factory. This urgency is dictated, in the first place, by the fact that it is possible and expedient to shift to Udokan the subdivisions of the Ministry of Transport Construction being freed from work at the BAM so that they can lay a 40-kilometer branch railroad line to the location of the future GOK, build an experimental quarry, and perform some installation work. They even mentioned to us a possible general contractor for this complex: the collective of Bratskgesstroy [Bratsk Hydroelectric Station Construction], which already has had the valuable experience of participating in the building of the Nadezhdinskiy Combine near Norilsk. Significant capacities of Bratskgesstroy are being freed right now at the projects of the Yuzhno-Yakutsk TPK [Territorial Production Complex]. In the second place, the experimental industrial factory is needed today to avoid planning errors and to accelerate the very process of the planning of the Udokan Combine, which has been delayed excessively. We remind you that the decisions of the 26th Party Congress indicated the necessity of "finishing the planning work for the Udokan Copper Deposit" during the current five-year plan.

But how can one speak of the conclusion of the planning work when the sectorial institute "Giprotsvetmet" has not even fulfilled the task confirmed by the USSR Gosplan and Gosstroy of working out a complete model for the distribution and development of a mining and enrichment combine at Udokan? Also undetermined is a diagram of the city. There is no map of slope formations, without which serious miscalculations are possible in selecting the routes of the transport lines. There has been no study of the dynamics of snow avalanches, earth movements on the slopes, and much more.

Since we have already brought up the main problems, we cannot ignore the question of the technology of ore transport for Udokan. The greatest volume of its ore will be extracted through the open method, which is least expensive. But in the work of opening it up, it will be necessary to move so much rock that even the country's largest mining enterprise would need more than 10 years to do the job. The idea was advanced of using powerful directed blasting, but this also does not eliminate the problem of equipment for ore transport of especially great productivity that is also adapted for work under the extreme conditions of the north and high elevations. Where does one obtain this special equipment? Specialists at the Mining Institute in Novosibirsk are now working out something, but the planning organizations of the Ministry of Nonferrous Metallurgy are putting their main hopes in regard to domestically built machines on the Zhodino 180-ton dump truck, the Uralsk excavators of 20 cubic feet capacity and the 140-ton dump cars. This would all be good, but these machines are being produced in very small numbers.

Here we have touched upon several fundamental problems and note that each time we were forced to say that they can be solved in different ways. Let us take the following example. Under review was a variant of a city at Udokan with a population of from 60,000 to 100,000 people. It is apparent that there is no need to explain how much more expensive construction of the maximum size would be. But still another variant is being advanced. Several thousand people will work at the GOK. The natural and climatic conditions are difficult here and that means that it is not necessary to have a city of 60,000. Let the people

live in Taksimo, for example, where there is no permafrost and where tomatoes and even watermelons ripen. And Taksimo is only 200 kilometers to the west on that same BAM, a completely acceptable distance for the shift method of development. Through the reduction in the size of the city and its social infrastructure, one can reduce capital investments for Udokan by many millions of rubles.

To put it mildly, the position of the Ministry of Nonferrous Metallurgy on Udokan cannot be called consistent. Here is just one fact. At a conference with the minister in July of this year, the decision was made, on the one hand, to ask for the allocation of rather large sums for the construction of transport approaches to the deposit and--finally!--for an experimental enrichment factory, which could have been seen as the first step toward developing Udokan. On the other hand, that same conference decided on "concentrated capital investments in the 12th and 13th five-year plans mainly for the development of the ore base of the copper industry of the Urals, Kazakhstan and Norilsk Combine," which says something entirely different: Udokan remained outside of the long-term interests of the sector.

Of course, much capital is needed for the development of Udokan. And one can understand the metallurgists when they mention a certain contradiction, when these resources are seen as allocations for the copper industry. There is indeed the perception of a forced argument here. In the economic structure headed by "Soyusmed'," Udokan appears as an insatiable little cuckoo bird in the nest of an oriole: it alone is capable of devouring the entire budget of this department. But does this not give reason to reflect on whether this system of financing is sufficiently good?

Let us cite still another circumstance supporting these doubts. "Udokan is not just copper," said Yu.A. Kosygin, academician and Hero of Socialist Labor, in a conversation with us, "its ore also contains other metals. The processing of the polymetallic sulfitic ores of Udokan will provide a large quantity of sulfuric acid, for which there is a great need in many sectors. By the way, the Transbaykal Region has large reserves of phosphates. With the acid, one can work out the production of mineral fertilizers, for which there is such a shortage in the agriculture of the entire eastern region."

Further, development of Udokan creates the base for putting other riches of the earth of the north of Chita Oblast to economic use. In Chara, V.S. Chechetkin, chief geologist of the Udokan Expedition, whose hair has turned as gray as the local peaks beyond the clouds, peaks that he has traversed over many years, unfolded before us a map of the region, and we saw that it was all literally studded with little circles and squares of various colors. Here, next to the BAM route, are found the large Apsatskoye Deposit of coking coal, several large deposits of magnetic iron ores with a very high metal content, the Sakunskoye Deposit of aluminum-potassium ore, the Kalarskoye Deposit of raw material for the production of cement--one cannot enumerate it all. In the huge strip along the BAM, there is no other place where such great natural wealth could be concentrated in a small area. It is doubtless here where the new Transbaykal industrial center will be established. And, in this connection, many prominent specialists, Transbaykal explorers M.V. Mokhosoyev, A.A. Nedeshev, L.P. Sarin, A.I. Trubachev, with whom we spoke, justifiably point out that it would be more correct to apply a complex special development program to Udokan than a sectorial program.

Well, the builders of the main railroad line have fulfilled their task. The steel road has been laid to the treasures of Chara Valley. The time has come to clear up the question of when Udokan's fateful hour will come.

From the editorial staff: Without a doubt, the problem of the development of the Udokan Deposit is complex in nature. It is quite clear that it will require the efforts of scientists, planners, builders and metallurgists. Back at the beginning stage of the construction of the BAM, a strategic line was worked out and expressed in party documents, where there were direct instructions to make provisions for the assimilation of the natural resources in this zone with the completion of the construction of the separate sections of the main railroad line. This applies fully to Udokan. This is why the interested departments, and above all the Ministry of Nonferrous Metallurgy as well as the USSR Gosplan and the USSR Gosstroy, must accelerate the pace in solving this important and promising national economic task, strictly adhering to the previously outlined plans. We hope that they will express their opinion on the questions raised in the article "Hour of Udokan."

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NEED FOR BETTER UTILIZATION OF MINERAL PRODUCTS

Moscow EKONOMICHESKAYA GAZETA in Russian No 30, Sep 84 p 2

[Article by P. F. Lomako, minister of USSR nonferrous metallurgy, under the rubric: "4th Year of Five-Year Plan: Raw Products Should Be Used Economically, Completely." Passages in uppercase appear in boldface in original source].

[Text] The production of nonferrous and rare metals along the entire technological chain--from mine to finished ingot--requires the strenuous work of hundreds of thousands of specialists and workers: geologists, miners, ore concentrators, metallurgists, transport workers, power engineers and representatives of other professions. For example, each ton of aluminum requires about six tons of bauxite or nine tons of nepheline ore tc be mined and processed into alumina, expenditure of about 4 gigacalories (10^9) of heat energy and 18,000 kw-hr, and the use of over 200 kilograms of chemical reagents.

The output of titanium, tungsten, molybdenum, tin and rare metals is quite labor-intensive and energy-intensive--in short, almost all our product list. And, as time passes by, ores with lower metal content and inferior technological properties have to be used.

We extract annually more than 2.5 billion tons of ore and stripped rock to satisfy the requirements of the contry for nonferrous and rare metals. Open pit mining is conducted at depths of 200-400 meters, and underground mines reach a kilometer or more. Of course, successful searching, prospecting, and making new deposits operational remain as the main direction in deciding the mineral product problem. Recently, Minister Ye. A. Kozlovskiy told about the work of Soviet geologists in the pages of "Ekonomicheskaya gazeta."

A number of large mining-concentration combines are being built now such as the Deputatskiy Tin Extracting Combine in Yakut ASSR, Zhayrem Polymetal Combine in Kazakhstan, Zhireken Molybedenum Combine in Chitinskaya Oblast, and Gorevskiy Polymetal Combine in Krasnoyarskiy Kray. However, the construction of large enterprises in unsettled area, which do not have an infrastructure, requires considerable finances, material and labor expenditures and, in respect to time, it generally goes beyond the framework of one five-year plan.

For this reason, parallel to the establishment of new large mining-concentration enterprises, geological prospecting operations are developed in areas of active

production. We conduct preliminary prospecting of flanks and deep levels of the deposits to be exploited. This ensures replenishment of used up capacities and provides a substantial increase to the nonferrous metal supplies.

MORE COMPLETE EXTRACTION OF ALL USEFUL COMPONENTS FROM ORE PRODUCTS, INTENSIFICATION OF TECHNOLOGICAL PROCESSES, AND INCREASED PRODUCTION OUTPUT WITH MINIMUM EXPENDITURES ARE ACQUIRING PRIMARY IMPORTANCE UNDER PRESENT CONDITIONS.

Work collectives of nonferrous metallurgy enterprises and organizations are successfully implementing plan goals and socialist obligations accepted for 1984: and, for this period the planned production of bauxite, alumina, aluminum, nickel, zinc, tin, titanium, magnesium, mercury, antimony, brass rolling, phosphorous and potassium fertilizers, calcined soda, and many important types of output is ensured. During the past eight months labor productivity by branches has grown by 4 percent, with a target of 2.3 percent, compared to January-August of last year. Product cost of commodity production has been reduced by an extra 0.8 percent.

Our metallurgists adhere steadily to the requirements, contained in the well known CPSU Central Committee decree on "Work of the Party Organizations of the Ust-Kamenogorsk Lead-Zinc Combine and the Balkhash Mining-Metallurgical Combine on the Mobilization of Collectives for Achieving High Indicators in the Complete Utilization of Ore Products." In 1983, as a result of complete processing of ore products, hundreds of thousands of tons of nonferrous metal concentrates have been produced as well as millions of tons of pyritic and barytic concentrates, quartz casting sands and other incidental outputs on nonferrous metallurgical enterprises.

The initiator of the innovation is the collective of the Ust-Kamenogorsk Lead-Zinc Combine that produced additional commodity output worth hundreds of thousands of rubles by increasing the extraction of zinc, lead and accompanying metals. Six hundred thousand rubles were saved in mineral products. Accompanying production output reached 53.7 percent in production volume. Quotas for processing oxidized ores, metal powders and other difficult to process types of ore products, as well as intermediate products, were fulfilled. In 1984 the Ust-Kamengorsk workers continue to increase the production of basic and accompanying metals and the utilization volumes of difficult to process ore products.

The basis for achieving the high indicators is the high technical level of production and the realization of new technological processes, as well as improvement of the existing ones. The kilns have been modernized at the combines and a new system for processing oxidized zinc products has been introduced. Other workers are also following the example of these leading workers.

AN IMPORTANT PROBLEM FOR THE COMPLETE UTILIZATION OF ORE PRODUCTS IS THE EXTRACTION OF METALS FROM METALLURGICAL SLAG.

Substantial capacities have been established for this purpose in the industry. In 1983 a priority rotary kiln complex had been put into operation at the

Leningorskiy Polymetal Combine. Here, zinc, cadmium, tellurium and indium are produced from the slag of lead melting. Processed scrap is used for the production of building materials.

In this way, about 700 thousand tons of slag containing zinc will be processed in the current year. More than 90 thousand tons of zinc and lead will be produced from them. According to the ministry, so far about 200 thousand tons of nonferrous metals are produced annually from the scrap and ores lying around. As we can see, the reserves are still fairly large.

Changing many enterprises to small- and no-waste technology is the problem that has to be solved in the current five-year plan and in the 12th. This is a matter of great importance to the state. No-waste technology solves the problem of complete utilization of mineral products and prevents environmental pollution as well.

PROBLEMS, RELATED TO THE CAREFUL USE OF NONFERROUS METALS BY CONSUMERS AND TO THE DEVELOPMENT OF SECONDARY NONFERROUS METALLURGY, DESERVE SPECIAL ATTENTION.

The main directions for using nonferrous metals carefully and raising the coefficient of their utilization in the consuming industries are the introduction of a rational pattern of rolling, progressive methods of casting and stamping, powder metallurgy, and substitution of nonferrous metals and alloys with less critical materials. Here, one has to admit that matters are not going too well.

In 1983, for machine building as a whole, the coefficient for use of rolling and drawn products from nonferrous metals is 0.716. This is lower than in 1980 (0.718). The indicator is considerably worse than the average at the enterprises of Minstankoprom [Ministry of Machine Tool Industry] and Minzhivmash [expansion unknown]. The coefficient for use of nonferrous metals fell from 0.7 in 1981 to 0.678 in 1983 at Minzhivmash.

For example, a considerable reserve for the economy is the production of non-tungsten hard alloys and cutting cermet. The use of a million plates made of non-tungsten alloys enables us to save up to 7.5 tons of expensive metal.

Growth of the Utilization of Hard to Process Ore Products and Production Scrap According to the USSR Ministry of Nonferrous Metals (1981 = 100 percent)

Year	Growth (Percent)
1981	100
1982	130.8
1983	133.8
1984 [anticipated]	154.2
1985 [projected]	165.5

The production of non-ground plates made of non-tungsten alloys increased from 4.5 million in 1980 to 12.2 million units in 1984. Much has been done, but the untapped potentialities are even greater.

Operations must be intensified for the production of especially pure, high-strength refractory metals and more efficient hard alloys. We are counting on the further close cooperation of the USSR Academy of Science Institutes and the scientific-technical community.

I shall dwell particularly on utilization of the hard alloy production of nonferrous metallurgy. In 1980-1983 a special production-technological bureau "Orgprimtverdosplac" of the USSR Ministry of Nonferrous Metals examined over 350 enterprises of the leading machine building ministries.

As an example, one can cite KamAZ [expansion unknown], where the consumption rates for hard-alloy, polyhedral, non-ground plates are signficantly reduced. Overall, the utilization of hard alloys has improved at the Ministry of the Automobile Industry, Ministry of the Electrical Technology Industry, Ministry of the Machine Tool Industry, and Minzhivmash.

However, there are no technically based consumption rates for hard alloys at a number of plants, and the operating rates are often overestimated. Significant losses of hard alloys have been found at the enterprises of the Ministry of Heavy Machinery Manufacture, Ministry of Construction and Road Machinery Manufacture, USSR Ministry of Ferrous Metallurgy, and Ministry of Chemical Manufacture.

THE COLLECTION AND DELIVERY OF REJECTS AND SCRAP AND THEIR USE IN SECONDARY PROCESSING ARE A GREAT SOURCE FOR COVERING THE NATIONAL ECONOMY REQUIREMENTS IN NONFERROUS METALS.

Unfortunately, many enterprises using 38 to 100 percent nonferrous metals turn over rejects and scrap that are mixed in types, alloy grades, and are contaminated with ferrous metals and debris. For a long time there has been a need for organizing the collection and delivery of sorted scrap materials and for making production-technological maps. So far, due to the absence of such order, unjustified losses have appeared. In 1983, during the metallurgical processing of mixed scrap, tens of thousands of tons of copper, zinc, tin, lead, silicon and magnesium had not been received.

Substantial reserves of secondary nonferrous metal resources are not used due to the absence of specialized technology and capacities for their processing with the separation of metals and alloys. For example, zinc is lost with the scrap of galvanized iron and parts, and with slurries of synthetic fiber production; copper, nickel, cobalt, tungsten, molybdenum, and tin are lost with rejects and the scrap of electric light production, household radio electronic equipment, and with galvanic production slurries.

Almost at all processing and machine building enterprises our State Inspection Board in examining trash, ready to be taken to the dump, finds nonferrous and even precious metals. In 1984, in test samples of city and plant dumps, dumping of nonferrous metals was reported for the Moscow plant "Foton", the "All Union Scientific Research Institute of the Cable Industry" of the Ministry of the Electrical Engineering Industry, the Moscow Plant imeni M. I. Kalinin of the Ministry of Construction and Road Machinery Manufacture and many others.

The collection of household scrap from the population is unsatisfactorily organized. As a result, 300 thousand tons of aluminum, copper, zinc, tin and lead are lost annually. To activate the specialized centers it is expedient to appropriate funds to the USSR State Committee for Material and Technical Supply for commodities in high demand (similar to scrap paper) or find other forms of stimulation.

Reject and scrap materials have already had some labor applied to them, and it is easier to convert them into metal than to make them from ores. Labor productivity in producing alloys from rejects and scrap is higher by a factor of 2.5 than from ores, and is higher by a factor of 5 for return on investment. Electrical energy expended for one ton in secondary aluminum production is lower by a factor of 75 compared to primary aluminum production. Melting of metal fro- rejects and scrap, prepared in 1983, is equivalent to the extraction of 45 million tons of copper, 12 million tons of lead-zinc ore, and more than 4.5 million tons of bauxite, nepheline and alumstone. There is every reason to count on a more substantial effect in the immediate outlook.

The workers of our industry, in preparing to meet the 40th anniversary of the Victory of the Soviet People in the Great Fatherland War and the 50th anniversary of the Stakhanovite movement with new labor successes, will do everything within their power to steadily provide the national economy with nonferrous, rare and precious metals and other important production.

12525
CSO: 1842/021

UDC 621.762

HIGH TEMPERATURE ANTIFRICTION PROPERTIES OF $Ti_{1-x}Nb_xC_{0.5}N_{0.5}$ ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84
(manuscript received 19 Jul 82) pp 81-84

TKACHENKO, Yu. G., ORDAN'YAN, S.S., YULYUGIN, V. K., YURCHENKO, D. Z., PANTELEYEV, I. B. and MASKHULIYA, L. G., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] The basic process controlling antifriction properties of contact materials at high temperatures in a vacuum is the degree of deformation and adhesion interaction. The present article reports on study of production, structure and properties of alloys with the composition $Ti_{1-x}Nb_xC_{0.5}N_{0.5}$. Initial carbide and nitride powders with dispersion of less than 60 mkm were mixed and pulverized, then shaped and caked in an inert medium, resulting in porosity of less than 1%. X-ray analysis showed formation of complex carbonitrides with TiC or NbC lattice structures. Granules were 2-6 mkm in diameter. Friction and wear tests were conducted in a range of 20-1200°C. Results showed that the carbonitride with 0.77 Ti had the optimum friction qualities, while titanium and niobium carbonitrides were the most brittle. The cobalt binder used contributed to ductile microdeformation. The powder composites tested are recommended for use in high-temperature friction assemblies. Figures 2; references 4: all Russian.
[42-12131]

UDC 534.282:539.67

EFFECT OF OPERATING MEDIUM ON CYCLIC DURABILITY OF AD33-W COMPOSITE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84 (manuscript received 1 Mar 83) pp 77-80

UTKIN, V. S., SALIBEKOV, S. Ye. and SAKHAROV, V. V., Vologda Polytechnical Institute

[Abstract] Effective use of unidirectional fiber composites of Al-W alloy is hampered by the lack of data on its behavior in operating mediums. One of the key features in corrosion prevention is insulation of Al-W composites and

boron filaments from active mediums. The present article reports on various attempts at increasing cyclic durability of such composites. These included degreasing with acetone and coating with a resin glue, followed by measurement of free oscillations, acoustic and chemical studies. After etching in a 10% solution of NaOH, under static load the AD33-W composite fibers began to break at a maximum stress point determined by accumulated damage. The working medium effected damage in correlation to the stress magnitude and medium corrosiveness. With less than 8% damaged fibers, the effect of corrosive media was negligible for as long as 150 hours. It is recommended that the AD33-W composite not be used in 3% NaCl solution and water without anti-corrosive measures. Figures 3; references 8: all Russian.
[42-12131]

UDC 539.213

STRUCTURAL DISTORTIONS OF ULTRA-DISPERSED TITANIUM NITRIDE POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84 (manuscript received 27 Dec 82) pp 12-15

PETRUNIN, V. F., ANDREYEV, Yu. G., MILLER, T. N., GRABIS, Ya. P., YERMOLAYEV, A. G. and ZELENYUK, F. M., Moscow Engineering Physics Institute

[Abstract] Ultra-dispersed titanium nitride powders of more than 100 nm show comparatively high chemical activity, reduced caking temperatures and superconductivity. The present article reports on structural studies of such powders by neutron diffraction and X-ray methods. Surface measurements ranged from 39,000 to 95,400 m^2/kg. Large-grained TiN obtained by sintering was the control. Neutronograms showed the similarity of the various powders, as well as their similarity to NaCl cubic structure. Nitride composition was essentially stoichiometric, and there was a tendency toward atom shift as mean surface of the powders increased. Smaller particles had decreased lattice constants along with increased static components in atom shift mean square roots. Part of this phenomenon was attributed to deformational heterogeneity. Figures 3; references 15: all Russian.
[42-12131]

UDC 621.762.3

DEGASSIFICATION OF SILICON NITRIDE POWDERS OF VARIOUS ORIGINS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84 (manuscript received 1 Mar 83) pp 9-12

ANDRIYEVSKIY, R. A. and LEONT'YEV, M. A, Moscow Institute of Fine Chemical Technology

[Abstract] While previous studies have been devoted to properties of silicon nitride powders, they have focused on their chemical composition. The present

article reports on degassification in a temperature range of 25-1500°C from silicon nitrides obtained by high-temperature self-propagation, direct and plasma chemical synthesis processes. Powders were then placed in degassified molybdenum capsules for further treatment. Hydrogen emission was measured by automatic coulometer titration, oxygen and nitrogen by vacuum smelting. Results indicated that plasma chemical powder, the most dispersed, had heightened levels of oxygen and silicon. Active gas emission began at 300°C, then stabilized or decreased by about 1100°C. Lowest emission levels were observed with high-temperature self-propagation powders and the lowest with those produced chemically. Compared to other powders, the silicon nitride underwent degassification over a wider temperature range, but eventual quantities emitted were similar. The optimum temperature for degassification was judged to range up to 500°C. Figures 2; references 6: 5 Russian, 1 Western.
[42-12131]

UDC 621.762:669.715

COMPOSITION AND THICKNESS OF OXIDE COATINGS ON GRANULE SURFACES OF ALUMINUM ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 84 (manuscript received 7 Feb 83) pp 4-9

ANTIPIN, V. P., DANILKIN, V. A., SIDOROV, V. A., KABANOV, S. Yu. and LARIN, N. V., Moscow

[Abstract] Properties of semimanufactured products of aluminum granules obtained by high-speed crystallization were studied by electron Auger-spectroscopy and secondary ion mass-spectrometry to determine thickness and composition of oxide coatings on A99 aluminum and an alloy containing 6% Mg, as well as other aluminum alloys, including ones with refractory components. Impurities stemming from the water used for crystallization were eliminated by using distilled water. Variations in the surface coatings were attributed in part to atomization procedures. The adjusted methods used provided acceptable coatings with no more than 10% variation in thickness. The vibration casting process provided coatings of 5-6 nm (or slightly more with A99). Similar results were obtained with centrifugal casting. Careful control of impurities was required, particularly in closed water cycle processes. Figures 3; references 7: 1 Russian, 6 Western.
[42-12131]

UDC 669-492.2

APPARATUS FOR PRODUCING AMORPHOUS AND MICROCRYSTALLINE METAL POWDERS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 5, Sep-Oct 84 (manuscript received 21 Jan 82) pp 122-124

SAVITSKIY, Ye. M. [deceased], YEFIMOV, Yu. V., DMITRIYEV, V. N., ANTIPIN, O. P., KANAVETS, I. P. and FROLOVA, T. M., Moscow

[Abstract] An apparatus has been developed for quenching metal melts at superhigh rates in production of powder with specified grain dimensions. A hermetically closed vat contains a quartz or corundum crucible seated in a furnace (electric-arc, resistance, induction, electron-beam, or any other type) with superheated molten metal or alloy. The melt is discharged from the crucible through an orifice-gate at the tip of the spherical bottom, pouring vertically downward as a continuous thin jet on the teeth of a variable-high-speed motor-driven heavy quencher gear-drum. The teeth break the jet into identical fine batches of metal, the latter being cooled in the process by the cold polished drum surface. Solidified microparticles do not get welded to the drum surface but break away from it and fall into a receptacle. The drum is cooled from underneath with liquid-helium jets while it rotates and melt pours on it eccentrically from above, which ensures a uniform temperature around its surface and thus a uniform quenching rate. The apparatus was tested with a melt jet pouring on the drum surface at a velocity with a tangential component of 1 cm/s and the drum with 250 teeth rotating at a speed of 12,000 rpm. The teeth had been designed for cutting off a 0.4-mm-thick layer of metal melt. The thickness of this layer is decreased further by the smearing-effect pressure. The melt quenching rate is inversely proportional to the melt layer thickness, which has been confirmed by experiments with molten nickel. Figures 1; references 5: all Western.
[36-2415]

UDC 669.15-194:621.181

SPECIFICS OF KINETICS OF POLYMORPHOUS CONVERSION UPON HEATING OF LOW CARBON STEELS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, Sep 84 pp 2-5

SUROVTSEV, A. P., YAROVOY, V. V., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A study is made of the structural and phase transformations upon heating of low carbon unalloyed steel containing 0.025-0.35% C. Specimens were heated at rates corresponding to furnace and induction heating, 7.5-200°C/min. Critical points were determined on a dilatometer and by measurement of residual resistivity in a double bridge circuit. It was found that the critical points as determined by dilatometry and relative resistivity agreed rather well. Three major temperature intervals were found: transformation of pearlite to austenite, no transformation, and transformation of ferrite to austenite. The interval of no transformation between the two transformations is broader, the lower the content of carbon in the steel. With a carbon content of 0.25% or more the two transformation temperatures are practically the same. Figures 3.
[011-6508]

UDC 539.4

COMPARISON OF DYNAMIC-TENSION AND CONSTANT-LOAD STRENGTH CHARACTERISTICS OF HEAT-RESISTANT MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 84 (manuscript received 14 Sep 83) pp 31-33

OSASYUK, V. V., OLISOV, A. N. and SHKABAROV, L. V., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] A relation between the strength characteristics of 12Kh1MF heat-resistant steel under dynamic tension and under constant load is established on an empirical basis. Some specimens of this material were tested at 575°C

under dynamic tension with time limit in a 1231U-10 machine, one lot slower for an elongation rate of 4 mm/min and one lot faster for an elongation rate of 11 mm/min; other specimens were tested at the same temperature under constant loads up to the level of tensile strength with short time-base (100 min) in an AIMA-5-1 machine. The data are respresented graphically in the form of stress(strength)-time curves, whereupon the latter are analyzed by replacement of strength under short-duration dynamic loads with strength under equivalent long-duration alternating loads and calculation of stresses on this basis by the method of piecewise curve averaging. This procedure yields a close agreement between experimental data and hypotheses which allow summation of percent lifetimes. Figures 3; references 3: all Russian.
[29-2415]

UDC 669.14.018.44:539.4

LONG-TERM STRENGTH AND FRACTURE CRITERIA FOR EI698VD ALLOY UNDER COMPLEX STRESS CONDITIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 4 Apr 83) pp 11-17

GOLUBOVSKIY, Ye. R., Moscow

[Abstract] Results are presented from a study of the long-term strength of EI698VD nickel-based alloy under homogeneous planar stress conditions. The major normal stresses are used as the stress state characteristics. Long-term strength equations and activation parameters of the fracture process under creep conditions in extension, extension with flexure and flexure with slight axial force are obtained. A long-term strength criterion is suggested for a complex stress state. The specimens used in the test were made by stamping from a disk about 700 mm in diameter, then heat treated under normal conditions with aging. The material parameter χ is found to vary with the activation parameters of the fracture process, varying if the fracture process is controlled by different mechanisms. Figures 7; references 9: all Russian.
[005-6508]

UDC 539.38

SOME SPECIFICS OF DEVELOPMENT OF FATIGUE AND CREEP IN HEAT-RESISTANT ALLOYS WITH ASYMMETRICAL MULTICYCLE LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 5 Jul 82) pp 17-22

GOLUB, V. P., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] An attempt was made to demonstrate the leading role of fatigue or creep in the fracture of heat-resistant alloys on the basis of thermal activation analysis, particularly analysis of the regularities of change in activation energy of the fracture process. A cycle of experimental durability

studies was performed over a broad range of stresses and temperatures to determine the values of the thermal activation parameters. Heat-resistant nickel-based alloys EI867, EP109, EVZhL12U and ZhS6U were used in the studies. The stress was changed at a rate of 35 Hz, and temperature interval of the studies was 800 to 1100°C. It was found that sudden changes in activation energy of fracture of heat-resistant nickel alloys indicates a change in the leading kinetic process controlling fracture from fatigue to creep at a critical value of amplitude. Figures 4; references 17: all Russian.
[005-6508]

UDC 620.1

CHANGE IN MICROSTRUCTURE OF HEAT-RESISTANT NICKEL ALLOYS UPON THERMAL CYCLING IN A CURRENT OF GAS

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 12 Apr 83) pp 37-40

TRET'YACHENKO, G. N., KRAVCHUK, L. V., KURIAT, R. I., SEMENOV, G. R., KOTIKOVA, T. D. and KHAUSTOVA, S. G., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] Tests are performed allowing maximum approximation of loading conditions of specimens to actual operating conditions. The tests were performed on wedge-shaped specimens with thermal cycling in a current of gas on a gas dynamic test stand. Specimens were made of heat resistant nickel-based alloys EI826 and EP539. The maximum specimen edge temperature was varied from 850 to 1035°C, maximum thermal stresses from 400 to 625 MPa. EI826 specimens were tested with a sawtooth temperature change cycle 70 seconds long, EP539 specimens were tested with holding at 900°C, total cycle length 120 seconds. Photomicrographs illustrate the microstructure of the materials near the edge of the wedge-shaped specimens and the nature of development of thermal fatigue cracks. A comparison of the results of the studies on the wedge shaped specimens with actual gas turbine blades indicates that the nature of fracture of the material can be used to estimate the area of temperature and loads to which the material has been exposed. Results of thermal cycling tests can be used to establish the causes of damage to actual elements based on the nature of damage to individual zones and to select fracture criteria under thermal cycling conditions. Figures 6; references 6: all Russian.
[005-6508]

UDC 669.295:621.78

DEVELOPING PROCEDURES FOR THERMOMECHANICAL PROCESSING OF HIGH-DURABILITY VT22 TITANIUM ALLOY

Moscow TSVETNYYE METALLY in Russian No 10, Oct 84 pp 84-87

POPOV, A. A., ANISIMOVA, L. I. and BONDARYUK, N. N.

[Abstract] Previous studies had shown that increasing tempering temperature from 625°C to 650°C brought spherization of particles; in the alpha-phase, recrystallization took place. Significant loss of durability and loss of plasticity were noted. The present article reports on studies of VT22 titanium alloy rods, previously tempered at 800 and 900°C, and then subjected to cold deformation processing. The resulting shaped rods were then aged at 450-700°C for 2 and 4 hours, and tested for blow resistance and breaking. The samples aged at 500-625°C emitted plate-like alpha-phase particles, but the coagulation found in hot-rolled products did not occur. This effect is attributed to reduction of resilient energy. Thus with other properties equal, cold-shaped alloys have higher plasticity and viscosity. Temperature and mechanical features of mixed alpha-beta alloys, where the fine platelet alpha-particles determine durability and larger particles determine plasticity, are discussed. Figures 5; references 6: 5 Russian, 1 Western. [33-12131]

UDC 621.785.3:669.295

INFLUENCE OF ANNEALING ON CYCLIC AND SHORT-TERM STRENGTH OF THIN SHEETS OF VT1-0 TITANIUM AND OT4 ALLOY

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 4, Jul-Aug 84 (manuscript received 15 Sep 83) pp 120-122

KOLOMENSKIY, A. B., MURAVYEV, I. I., KOLACHEV, B.A.and SHEVCHENKO, V. V.

[Abstract] A study is presented of the influence of the state of the surface and structural changes after annealing in air and in a vacuum on cyclical and short-term strength of thin sheets of VT1-0 titanium and OT4 titanium alloy. Studies were performed on specimens 1.5 mm thick (VT1-0) and 1.2-2.0 mm

thick (OT4) annealed at temperatures of 350 to 750°C for one and two hours in air muffle furnaces and in a vacuum furnace with residual pressure not over $6.65 \cdot 10^{-3}$ Pa, leakage not over 5.25 $dm^3 \cdot Pa/s$. The influence of surface oxidation and gas content on mechanical properties as studied on specimens which underwent preliminary vacuum annealing in packets at 660°C, two hours or 750°C, one hour for VT1-0 and 750°C, two hours for OT4. The relief of characteristic surface hardening during annealing significantly decreased their cyclical and short term strength. The status of the surface after air and vacuum annealing influences short-cycle endurance at over 75% of the tensile strength but has practically no influence on long-term endurance at less than 75% of tensile strength for these alloys. An oxide film developed by annealing in air decreases repeated static loading endurance, cyclical loading strength and short-term tensile strength of both alloys. Figures 3; references 4: all Russian.
[013-6508]

UDC 669.295.7

RATIONAL USE OF TITANIUM IN NONFERROUS METALLURGY

Moscow TSETVNYYE METALLY in Russian No 10, Oct 84 pp 31-33

DOBRUNOV, Yu. V., ALEKSANDROV, V. A. and VOLYNSKIY, V. V.

[Abstract] Economies in using titanium in nonferrous metallurgy are crucial given limited supplies of the metal. The present article outlines Soviet use of titanium and points out approaches to achieve more rational use. Soviet titanium use includes specialized titanium equipment, less standardized products, and repair and related uses. Wear patterns suggest that 20% reductions in thickness could be made in titanium-magnesium alloys used in various sterilized equipment, in rare-earth production equipment, in nickel and cobalt production, and in other specialized metal products and sulfuric acid products. Tests with hydrochloric acid, including saturating concentrations in hydrolysis, were pursued until they caused titanium destruction. Results showed that the shortest service came from stamp-welded and cast titanium pumps, which broke down in 1-1.5 years due to abrasive and corrosive wear. In designing titanium components, aggressive agents and temperature must be taken into consideration. Sharp angles and other design features must be carefully controlled. The small linear expansion coefficient, cold durability and high corrosion resistance to certain compounds make titanium alloys especially useful for tubes of 100-400-mm diameter with 2-5-mm walls, for chemically and thermally durable products. Titanium-steel bimetal products also have great potential.
[33-12131]

STUDIES OF ELECTRICAL PROPERTIES OF SURFACE FILMS AND LOCALIZATION DURING ELECTROCHEMICAL DIMENSIONAL WORKING OF TITANIUM

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 28 Dec 82) pp 14-17

RUMYANTSEV, Ye. M., NEVSKIY, O. I., VOLKOV, V. I. and GRISHINA, Ye. P., Ivanovo

[Abstract] An estimate is presented of the localization of the process of dissolution of titanium alloy VT1-0 in electrolytes. The logarithmic scattering index is determined by a method which has been recommended as a standard and is distinguished by the fact that the specific rate of metal removal is recorded for each value of interelectrode gap by a given period of time. It was found that addition of the bichromate ion results in an increase in A_{eff} as a result of formation of a surface film of a new composition with different properties than in the initial NaCl solution. In systems where the anodic potential is a significant fraction of V_c, the secondary distribution of current significantly influences localization of electrochemical dimensional working. A necessary condition for a high degree of localization is presence on the surface being worked of a film whose electrical resistance undergoes significant changes over a narrow interval of interelectrode gap. Figures 5; references 7: all Russian. [007-6508]

UDC 669.295'71'6:539.379.4

BASIS AND PYRAMIDAL SLIPPING IN SINGLE CRYSTALS OF α-ALLOY Ti-Al-Sn

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 2, Aug 84 (manuscript received 3 Nov 83) pp 383-388

AGEYEV, N. V., RUBINA, Ye. B. and KOVALEVA, V. N., Institute of Metallurgy imeni A. A. Baikov, USSR Academy of Sciences

[Abstract] Finely dispersed Ti-Al-Sn alloys were studied. A single crystal ingot 20 mm in diameter was grown by electron beam zone melting. Specimens were oriented so that the axis of compression was at about 14-18° or 45° [0001] axis. The side and end faces of the specimen were mechanically ground and electrically polished before deformation. The deformation mechanism was identified by means of tracks on the two surfaces observed with a GM double optical goniometer. Space slipping was observed at 293 and 77°K upon compression of the single-crystal specimens in the $\langle 11\bar{2}2 \rangle$ direction. With an orientation of the compression axis of $\langle 11\bar{2}6 \rangle$, active slipping occurs in $\{10\bar{1}1\}\langle\bar{1}123\rangle$ at 293 and 77°K; at 4.2°K crystals of this orientation are deformed by twinning. Orientation boundaries of activity of various deformation systems in Ti-Al-Sn single crystals are calculated in compression and extension at 293°K. Figures 6; references 7: all Western.

UDC 669.295:539.4.015

SPECIFICS OF STRUCTURE AND MECHANICAL PROPERTIES OF METASTABLE β-TITANIUM ALLOYS AFTER DEFORMATION AND AGING

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 2, Aug 84 (manuscript received 19 Jul 83; in final form 30 Sep 83) pp 377-382

YELKINA, O. A., SUDAREVA, S. V., MESHCHANINOVA, L. S., LERINMAN, R. M. and SHASHKOV, O. D., Institute of Metal Physics, Ukrainian Scientific Center, USSR Academy of Sciences

[Abstract] A study is made of low-alloy β -titanium alloys in the system Ti-Mo, Ti-Mo-Al, Ti-Mo-V, Ti-Mo-V-Al, compositions selected to avoid the formation of athermic α"-martensite upon hardening from the area. The purpose of the study was to determine how discontinuous decomposition occurs in metastable β-titanium alloys, whether it follows the classical conception of this mechanism of decomposition, or the appearance of cells with lamellae of α and β phases is accompanied by the ordinary process of recrystallization occurring in deformed alloys. It is found that cold deformation of Ti-Mo, Ti-Mo-Al alloys results in a phenomenon similar to the trip effect in steels. A large number of α"-martensite plates and twins with BCC lattice is formed. After deformation and subsequent aging of these alloys seeds of discontinuous decomposition arise at the points of intersection of deformation plates, where large stresses are concentrated. These areas apparently are responsible for the plasticity of the alloys. The deformation plates of α"-martensite break down to form a finely dispersed periodic modulated structure of α and β phases resistant to heat treatment. Sectors of the alloy which do not undergo transformation upon deformation and deformation plates with BCC structure break down to form finely dispersed mixtures of α and β phases. This structure is responsible for the strength properties of the alloys. Figures 2; references 7: 3 Russian, 4 Western. [010-6508]

WELDING

HULL SECTIONS OF CARRIER WELDED IN WATER

Moscow IZVESTIYA in Russian 23 Nov 84 p 3

[Article by S. Troyan]

[Text] Kherson--A lighter carrier has been launched and its two hull sections welded together while afloat. It has been named for the Soviet Party and government figure Sharaf Rashidov.

It has not been long since the "Aleksey Kosygin", the first of this new series of vessels, sailed from the fitting-out berths of the Kherson [Shipbuilding] Production Association to start sea trials. And already the shipbuilders have a new achievement to their credit: the second giant came off the slips right on schedule.

With the help of scientists of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton, the shipyard's workers have learned how to 'join' the motor ship's bow and stern sections directly in the water, using the method of caisson welding. The sides of the ship are as tall as a seven-story building.

The vessel's length exceeds 250 meters. A hull of the reinforced ice class will permit the motor ship to 'work' at high latitudes. Its port of registry will be Vladivostok. The vessel is able to take on board 82 barges with a load of 40,000 tons.

FTD/SNAP
CSO: 1842/50

1985 PLEDGES OF ELECTRIC WELDING INSTITUTE

Kiev PRAVDA UKRAINY in Russian 30 Dec 84 p 1

[Abstract] The article announces socialist pledges for 1985 made by the personnel of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton (IES).

The institute's staff has pledged to carry out and introduce not less than 120 technological and design developments over and above those which are planned, including a process for centrifugal electroslag casting of blanks for high-pressure reinforcements of gas-condensate field structures; a process and equipment for electron-beam welding of rotors for gas-turbine blowers at the "Neva Plant" production association; the first two complexes for friction welding of bimetallic valves for the engine of a new "Zaporozhets" motor vehicle; and three types of powder materials for gas-thermal deposition of protective coatings.

Among the other pledges are: preparation of three doctoral and 20 candidate dissertations; upgrading the qualifications of not less than 950 industrial welding engineers at the IES training center; and commissioning a laboratory building with an area of 7,000 square meters and expanding experimental production area by 1,500 square meters.

A photograph is given showing academician B. Ye. Paton, director of IES, and B. A. Movchan and V. K. Lebedev, members of the Ukrainian academy and heads of departments of the institute, discussing a piece of equipment.

FTD/SNAP
CSO: 1842/50

UDC 621.791.011:669.71

PROBLEM OF PORE FORMATION MECHANISM IN WELDED JOINTS OF ALUMINUM ALLOYS IN THE SYSTEM ALUMINUM-MAGNESIUM-LITHIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 8, Aug 84 pp 41-43

RYAZANTSEV, V. I., candidate of technical sciences and FEDOSEYEV, V. A., engineer

[Abstract] Studies were performed to determine the causes and mechanism of pore formation in alloys in the system aluminum-magnesium-lithium. Specimens 1 to 10 mm thick and panels of both experimental and commercial alloys were used. Various methods of melting by fusion were used, including manual arc welding in argon, automatic AC welding in argon and DC welding in helium, welding with electromagnetic agitation and in chambers with a controlled atmosphere. Analysis of X-ray diagrams indicated that no matter what the welding method the nature of placement of pores was identical, a chain along the melting line. Porosity was found to be related to the presence of a 0.05-0.15-mm surface layer rich in compounds of lithium and oxide films with adsorbed moisture. The surface layer contains 10 to 30 times more hydrogen than when surfaces are treated by heat and vacuum, 60 times more in comparison to type 1201 alloys. When a thin surface layer is removed, porosity arises only after long-term storage as a result of the presence of oxide films with adsorbed moisture. Changing the hardening temperature from 450 to 400°C decreases the thickness of the surface layer which must be removed to obtain pore-free welded joints from 0.12-0.15 to 0.05-0.07-mm. Figures 1; references 7: all Russian.
[006-6508]

UDC 621.791.754'293.052:62-761:669.295

PROPERTIES OF WELDED JOINTS IN ARGON ARC WELDING OF TITANIUM ALLOY USING A PROTECTIVE COATING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 8, Aug 84 pp 28-29

MOZEYKO, B. Yu., engineer and BAZHENOV, V. V., doctor of technical sciences

[Abstract] Arc welding of titanium alloys using coatings to protect the back side of the seam from gases uses various technological approaches depending on the type of joint to be made. Locations of coatings are illustrated for various types of butt, lap and tee joints. Optimal conditions of automatic welding of longitudinal seams in flat specimens were found to be I_w for 98A, V_w = 8.5 m/hr, L_d = 1.8 mm, Q_{Ar} = 0.012 m^3/min for welding using the protective coating: I_w = 105 A, V_w = 8 m/hr, L_d = 1.8 mm, Q_{Ar} = 0.012 m^3/min for welding in argon. The ductility of welded joints produced using the protective coating was higher than joints made by welding in argon. The endurance was also higher. The tensile strength and impact toughness were approximately the same. Reliability in service was also approximately the same. Figures 3; references 2: both Russian.
[006-6508]

UDC 621.791.09:621.785:669.295

THERMAL HARDENING OF WELDED JOINTS IN TITANIUM ALLOYS WITH VARIOUS STRUCTURES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 8, Aug 84 pp 26-27

KHOREV, M. A., engineer

[Abstract] A study was performed on pseudo-α alloys VT20, OT4; $\alpha+\beta$ alloys VT6S, VT14, VT23; and β alloys VT19 and TC6. Welded joints 3 mm thick made by automatic argon arc welding were annealed, hardened and strengthened over a broad range of temperatures. The comparison was based on optimal conditions providing the maximum strength while retaining satisfactory ductility with angle of flexure 25-30° and impact toughnesses 0.25-0.3 mJ/m^2. It is found that the effectiveness of strengthening heat treatment is maximal for alloys containing β stabilizing elements in a quantity equivalent to 8% molybdenum (the alloys tested contain 1.6 to 25%). It is shown that strengthening heat treatment can increase the strength of welded joints not only of $\alpha+\beta$ and β but also of pseudo-α alloys. A specific approach is required to selection of methods and conditions of strengthening heat treatment for each type of alloy. Figures 3; references 4: all Russian.
[006-6508]

UDC 621.791:621.643.23

INFLUENCE OF WELDING DEFECTS AT MELTING BOUNDARY ON STATIC STRENGTH OF WELDED JOINT IN LARGE-DIAMETER PIPE

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 84 (manuscript received 31 Aug 83) pp 111-116

SHAKHMATOV, M. V., YEROFEYEV, V. V., LUPIN, V. A. and OSTSEMIN, A. A., Urals Scientific and Technological Institute, Chelyabinsk

[Abstract] A study is made of the influence of nonpenetrating defects, both internal and superficial, located at the boundary between the soft base metal and hard welded seam metal on the strength of the welded joint in large-diameter pipes. The theoretical analysis is performed by the method of slip lines or static stress on welded joints assuming planar deformation, a valid assumption for large-diameter pipes. The influence of residual welding stresses is ignored. The soft metal is considered ideally rigid-plastic, the seam metal rigid. Calculation equations are suggested for estimation of the stress state and strength under these conditions. The results of an experimental study of the influence of defects of this type agree satisfactorily with the results of calculation. It is found that there is a range of permissible defect size which does not decrease strength of welded joints of this type. Figures 6; references 17: 16 Russian, 1 Western.
[005-6508]

UDC 621.791.4.052:539.378.3:669.15-194.2:620.17

MECHANICAL PROPERTIES AND BRITTLE FRACTURE RESISTANCE OF WELDED MULTILAYER ELEMENTS FOR HIGH PRESSURE VESSELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 84 (manuscript received 5 May 83; in final form 9 Jan 84) pp 27-30

GORITSKIY, V. M., KABANOV, V. S., KLIMOV, S. A., candidate of technical sciences, Central Scientific Research Institute for Planning of Steel Structures; KAZAKOV, N. F., doctor of technical sciences, ANTONOV, V. P., candidate of technical sciences, and TRIFONOV, V. A., engineer, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] A study is made of the influence of diffusion welding conditions on the strength of bonding between layers and brittle fracture resistance of multilayer products of steels types 16G2AF and St08kp. The strength of the interlayer bonding of the plates was determined by tensile testing. Brittle fracture resistance was studied on a 17-layer specimen with a sharply notch across the plates. Impact toughness was determined in specimens with the notch plane oriented perpendicular to the joint plane of diffusion welding of layers. It was found that joints equal in strength to the base metal can be produced by welding under a pressure of at least 9.8 MPa, holding time 20 minutes, welding temperature 1173-1273°K, residual pressure 1.33-0.133 Pa. Impact toughness in specimens with a notch in the plane perpendicular to the plane of diffusion welding yielded viscous fracture. When the notch was parallel to the plane of diffusion welding impact toughness dropped to 49-78 kJ/m^2. Changing the temperature of diffusion welding can regulate bonding between layers of a multilayer product and brittle fracture resistance. Figures 4; references 3: all Russian.
[003-6508]

UDC 621.791.052:[539.4+539.214]:669.715

ANALYSIS OF STRENGTH AND DUCTILITY OF WELDED JOINTS IN AMtsS AND AMg5 ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 84 pp 71-72

GRUDZINSKIY, B. V. and FOMCHENKOV, A. T., candidates of technical sciences, and MURKINA, N. G. and YEREMEYEV, A. N., engineers

[Abstract] Results are presented from statistical analysis of strength and bending tests of welded production specimens over a period of five years. Analysis considered the type of alloy, state delivered, thickness of metal and welding methods. No significant variation in short-term tensile strength of welded joints was found as a function of method of welding (manual argon arc or mechanized plasma), thickness of metal or delivered conditions (hot rolled or annealed). All samples of AMtsS alloy met the requirements of the

state standard. Welded joints in AMtsS alloy also have good ductility regardless of the variable factors. The strength of AMg5 welded joints varies broadly, primarily as a function of the status of the seam metal. Seventy percent of the specimens broke through the seam, apparently a result of burning of magnesium during welding. Ductility of welded joints in this alloy depends significantly on the thickness of the metal, less on the method of welding.
[003-6508]

UDC 621.791.4:539.378.3

EFFECT OF PROTECTIVE MEDIUM ON DURABILITY AND FRACTURE STRUCTURE ON SEAM ZONES OF THIN-WALLED TITANIUM ARTICLES PRODUCED BY DIFFUSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 84 pp 21-22

GUSEV, S. I., engineer, PESHKOV, V. V., candidate of technical sciences, MILYUTIN, V. n., engineer and SHORSHOROV, M. Kh., doctor of technical sciences

[Abstract] Currently machinebuilding makes wide use of thin-walled articles with high durability, rigidity and small metal expenditure. The present article discusses diffusion welding for seams in such articles using imitations consisting of cylinders of VT15 alloy with a beta-structure and a facing of OT4 alloy with fine-grained structure. Welding was done at 850-950°C at welding pressure of 0.4 MPa and time of 7.5-90 minutes, in a vacuum or argon medium. Structural strength was then assessed. Analysis of data showed that seam durability was dependent on welding temperature along with the protective medium used: a vacuum of $3.3 \cdot 10^{-3}$ Pa gave better durability than the argon or a 3.3 Pa vacuum. Where welding was done at 950°C, breaks came in the cylinder of VT15 alloy, while at lower welding temperatures the welded seam failed. When however, 0.002% O_2 and 0.01 N_2 were added to the argon medium, better joints were obtained than with the 3.3 Pa vacuum. Figures 4; references 3: all Russian.
[34-12131]

UDC 621.791.4:539.378.3

TECHNOLOGICAL PARAMETERS OF DIFFUSION WELDING PROCESSES IN HONEYCOMB TITANIUM ALLOY STRUCTURES

Moscow SVAROCHNOYE PROIZVODSTVO No 10, Oct 84 pp 12-14

PESHKOV, V. V., candidate of technical sciences and GUSEV, S. I., engineer, Voronezh Polytechnical Institute

[Abstract] Increasing use of titanium honeycomb designs in industry inspired the present study of procedures for obtaining highly durable lining seams. Diffusion welding and the high-temperature creep of titanium alloys depends greatly on microstructure, and these factors were taken into consideration

in designing the diffusion welding procedures. Metallographic analysis of the OT4 alloy leaf of 0.5-1.0 mm thickness showed its finely grained structure with no clearly delineated alpha-phase granules. Samples were then tested for thermal durability and for warping at 800-1000°C. The importance of initial microstructure of the alloy and the nature of applied welding pressure were determined to be important factors in determining durability. Either pressure application after the procedure is under way or use of a filler with large-grained platelet structure was found to provide successful welds. Figures 6; references 5: all Russian.
[34-12131]

UDC 621.791.05

DURABILITY OF VT16 ALLOY COMPOUNDS OBTAINED BY DIFFUSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 84 pp 11-12

KAZAKOV, N. F., doctor of technical sciences (deceased), MASHKOVA, N. A., engineer, VARYANITSA, V. Yu., candidate of technical sciences, YERMAKOVA, N. V., engineer and FEDOROVA, O. V., engineer

[Abstract] Durability of diffusion welded samples was assessed to determine optimum conditions for producing welded joints. Joint durability and the nature of failures were the criteria for selecting welding parameters. Diffusion welding in a vacuum at high temperature and pressure were found to change properties of the materials welded, providing high durability while harming use properties. Plastic properties were calculated in order to predict likely outcome of welding operations. Results showed that the best welding procedure, on the basic metal, provided both high durability and high plasticity, and thereby sought-after wear resistance. Study of surface porosity in test samples furthered confirmed these conclusions. Welding temperature of 1170°C for 120 minutes at 8 MPa in a 10^{-1} vacuum were the recommended parameters.
[34-12131]

UDC 621.791.002.5-192:007.52

RELIABILITY OF ROBOTIZED WELDING APPARATUS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 84 (manuscript received 2 Dec 84, in final edition 18 Apg 84) pp 61-65

TIMCHENKO, V. A., candidate of technical sciences, and TARATUTA, A. S., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] The operation of a robotized welding machine is broken down into two classes of functions, H-functions characterizing continuous use of equipment and II-functions characterizing periodically implementable procedures.

Functions of both types are described in terms of time parameters and nonfailure probabilities, for the purpose of reliability and economic analysis. Reliability estimates are based on digital computer simulation of process and probability characteristics, rather than on generally inadequate analytical models, with the nonfailure probability stipulated as an exponentially decreasing function of time. In an overall reliability estimate for a typical robotized arc-welding machine are included 13 components of the robot-welder system: robot controls, automatic manipulators, manipulator drives, welder controls, power source, electrode feed mechanism, gas feed mechanism, torch dressing mechanism, programmer, adaptation panel and adaptation channel. Calculations for the UD-223 robotized welding apparatus built at the Institute indicate that welding equipment and controls are the weakest links here, the probabilities of their failure-free operation over an 8-hour shift being only 0.95 and 0.975 respectively, while better robots now available can operate failure-free for 1000 h. The authors thank Yu. G. Zarenin, doctor of technical sciences, for providing data and discussing the material. Figures 2; references 4: all Russian.
[28-2415]

UDC 621.791.72.05:621.373.826:669.14.018.2:620.18.004.2

STRUCTURE AND MECHANICAL CHARACTERISTICS OF HETEROGENEOUS JOINTS PRODUCED BY LASER WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 84 (manuscript received 21 Feb 83, in final edition 23 Dec 83) pp 46-49

GREZEV, A. N., candidate of technical sciences, GRIGOR'YANTS, A. G., doctor of technical sciences, FEDOROV, A. G. (deceased), doctor of technical sciences, and IVANOV, V. V., candidate of technical sciences, Moscow Higher Technical School imeni N. E. Bauman

[Abstract] Welding together different grades of steel is common practice in the manufacture of automobile transmissions, typically with parts made of St35 steel and 12Kh2N4A steel respectively being joined. A comparative evaluation of three welding methods for such joints was made on the basis of microstructural examination and mechanical tests, taking into consideration nonisothermal phase transformations at various cooling rates. Laser welding and electron-beam welding were both found to produce seams with much narrower thermal influence zones and a finer grain structure in 12Kh2N4A steel than argon-arc welding, especially at high cooling rates, the highest toughness and resistance to cold cracking being found after laser welding. In St35 steel, with a higher carbon content and no other elements except impurities, laser welding was found to produce a high microhardness and low plasticity with resulting lower toughness and resistance to cold cracking than in the alloy steel. Figures 5; references 4: all Russian.
[28-2415]

UDC 621.791.12.052:669.71:539.4.001.24

METHOD OF CALCULATING STRENGTH OF JOINT PRODUCED BY COLD WELDING OF ALUMINUM UNDER DISCRETE LOADING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 84 (manuscript received 27 Oct 83) pp 29-31

KULAGIN, D. P., engineer, All-Union Scientific Research Institute of Electric Welding Equipment

[Abstract] Discrete increasing of the load with a movable vibratory tool during cold welding of aluminum has been proposed, with a smaller force required than for increasing the load continuously. In order to evaluate the effectiveness of this method, it has been necessary to determine the strength of a joint produced by it. This was done on the basis of a probabilistic model of randomly distributed contacts which mating metal surfaces make after cracking of the oxide films during plastic deformation. Data for this model were gathered in experiments with discrete loading (N= 2-16 operations), also with continuous loading (N= 1 operation) for reference. Discrete loading was effected in two ways, by decreasing the force to zero after each "pulse" with definite time intervals between successive "pulses", or by increasing the force in steps and holding at constant levels for definite time intervals between steps. Theoretical relations have been derived for the contact surface distribution and the effective breakdown force, as basis for calculating ultimate strains and stresses. These calculations reveal that the strength of an aluminum joint produced with pulse loading depends on the final strain as well as on the magnitude and the repetition rate of pulses. When the interval between pulses is shortened sufficiently and a certain threshold level is exceeded as the pulses increase in magnitude, then the strength of such a joint approaches the strength of one produced with step loading or with continuous loading. Figures 2; references 4: all Russian. [28-2415]

UDC 621.791.754.052:669.715:620.17:531:424

EFFECT OF MOISTURE IN INERT GASES ON DENSITY OF SEAM METAL AND ON MECHANICAL CHARACTERISTICS OF WELDED JOINTS OF ALUMINUM AND ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 84 (manuscript received 17 Aug 83, in final edition 7 May 84) pp 17-19

DOVBISHCHENKO, I. V., candidate of technical sciences, MASHIN, V. S., engineer, and RABKIN, D. M., doctor of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] A study was made of mechanized bilateral welding of AD-0 commercial aluminum and of aluminum-magnesium alloys (AMg3, AMg5) with a fusible electrode and nonparting edges, for the purpose of determining the effect of moisture in the inert gas shield on the porosity of the seam metal and on the mechanical

characteristics of the joint. Welding was done with an A1431 electric torch energized through a VDU-514 rectifier in a shield of either high-purity argon or a 75% He+ 25% Ar mixture. Plates of AD-0 aluminum and wires of AMg3 or AMg5 aluminum alloy were welded with a SvAMg5 rod, after their surfaces had been cleaned with lye and nitric acid (the surfaces of plates were then also scrubbed), an an ambient atmosphere at 20°C with 72% relative humidity of air. The moisture in the gas shield was measured with a KIVG instrument, accurately within $\pm$5%, and the volume of pores in the seam metal was measured by hydrostatic weighing. The joints were mechanically tested, after deburring of the seam on both sides. The results reveal that adding 0.1-0.8 g/m^3 of moisture to a pure aron shield increases the volume of pores in welded commercial aluminum up to eightfold, about twice as much as does adding moisture to a helium-argon shield, while the porosity of seam is 50-60% lower after welding in a dry helium-argon shield than after welding in a dry pure argon shield. The effect of moisture in the two gas shields is similar but less appreciable in the case of aluminum-magnesium alloys. Accordingly, the mechanical characteristics of joints are less sensitive to and not as much degraded by moisture in the gas shield when aluminum-magnesium alloys are welded than when commercial aluminum is welded. Figures 2; references 11: 7 Russian, 4 Western.
[28-2415]

MISCELLANEOUS

PULSED CIRCUIT METHOD FOR SCARFING INGOTS AND LAYING OUT METAL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Dec 84 p 4

[Article by L. Rodzinskiy]

[Excerpt] A scientist drew a wavy line with a pencil on a sheet of metal and pressed contacts of wires from a generator against it. A switch was turned, and a loud crack was heard in the laboratory. And then I held in my hands the two halves of the sheet, which had split along the line drawn on it.

"We didn't have to revolutionize physics in order to propose this method for cutting and laying out metal," said Candidate of Physical-Mathematical Sciences G. Okonishnikov. "The method is based on a phenomenon which was known as early as the last century."

Electrical engineers have begun to demand metals which are more and more homogeneous. Surface flaws on ingots may be passed on to parts made from them and become the cause of failures. To prevent this from happening, cutters burn out defects with torches before the ingots leave the foundry.

What relationship would this problem appear to have to new metal-cutting methods, and especially to scientists of the Department of Physical-Technical Problems of Power Engineering of the USSR Academy of Sciences' Urals Research Center, where G. Okonishnikov is head of a laboratory? The answer is simple: associates of this laboratory established that metal in the zone of defects heats up with particular intensity when current is fed to it non-continuously, in pulses. They proposed using this phenomenon.

"After the power and duration of the electric pulse have been selected, the metal in the flaw zone can be heated to any temperature, even to the point of melting," related the scientist. "The bulk of the ingot remains relatively cold while this is going on. But tiny points of melting form around the flaws. Molten metal fills cavities, cracks and scratches. As a result, the metal heals itself, so to speak."

The method which the scientists have proposed makes it possible to dispense with ingot scarfing, reduces losses of metal, sharply improves working conditions and heightens productivity. The next step which the researchers took was a logical one.

"We then thought: if metal melts intensely in the zone of scratches and cracks, then couldn't this process be made an explosive one? This turned out to be possible," said G. Okonishnikov. "For example, one has only to scratch a line on a piece of sheet metal and 'hit' it with the proper pulse, and an 'eruption' of metal occurs along this line. And the sheet is cut instantly."

Parts with very complex shapes can be obtained from sheet metal by this method. Cutting tools are no longer necessary, and broad possibities are opened up for automating the process. And the researchers are going beyond this.

"We ca- calculate the direction of the electric field in such a way that a line does not even have to be scratched; drawing it with a pencil will suffice," the scientist said in conclusion. "In principle, lines can be dispensed with altogether, and the unit can be outfitted with a programmed control system which will arrange the contacts along the line of the cut. Step by step, these contacts will 'explode' the metal, leaving a smooth cut behind them."

FTD/SNAP
CSO: 1842/50

ROLLING PROCESS WITH THREE-HIGH STAND IMPROVES METALS' PROPERTIES

Moscow SOVETSKAYA ROSSIYA in Russian 22 Nov 84 p 1

[Article by G. Zazvonov, (Elektrostal')]

[Excerpt] At the "Elektrostal'" Plant imeni Tevosyan in suburban Moscow, a test sample of rolled metal has been obtained on the country's first unit which operates with a process that is new in principle.

This rolling stand appeared a few years ago in a laboratory of the Moscow Institute of Steel and Alloys' chair of pressure treatment of metals. It was installed by workers and engineers of the trust "Metallurgprokatmontazh" (metallurgical rolling equipment installation). In appearance, there is little difference between the new unit and others that are in metallurgical complexes, aside from the fact that its dimensions are a little smaller. Such stands are ordinarily used for rolling pipes. But a task which was daring and seemingly impossible was conceived in this laboratory: namely, the rolling of cast or forged blanks between three rolls. Professor P. Polukhin, president of the steel and alloys institute, and Professor I. Potapov proposed this new process. The laboratory's experiments were crowned with success. The decision was made to build the unique rolling mill in suburban Moscow.

"Steel is not the only metal that can be worked with the new mill," related P. Polukhin. "The three-high stand is installed in the front part of the line. The secret of the process lies in this mechanism. The rolls in it slant at a sharp angle, and it is as if the blanks 'screw' into them, so to speak. The material that emerges is dense and homogenous and has a fine structure. Associates of our institute have intentionally rolled rejected metal which had cavities and cracks. The stand 'cured' all of its inner and external defects."

These are not all of the merits of the new process. The behavior of steels and alloys of different classes--stainless, tool, bearing, carbon and other metals--has been thoroughly studied by the scientists. And they are convinced that the process improves the service properties of these metals by 100 percent.

FTD/SNAP
CSO: 1842/50

UDC 620.178.3

CHARACTERISTICS OF SURFACE CRACK DEVELOPMENT IN AMtsS ALUMINUM ALLOY DURING SLOW-CYCLE LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 84 (manuscript received 27 Feb 84) pp 28-31

KAPLINSKIY, A. L., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] Surface cracking of the weldable high-plasticity AMtsS aluminum-manganese alloy under cyclic loads was studied experimentally on 10-mm-thick rolled strip specimens. The mechanical characteristics of this material at room temperature (293°K) are: 0.2% yield strength 111.7 MPa, ultimate tensile strength 140 MPa, percent elongation 28.4, percent reduction 50.5, modulus of elasticity $5.8 \cdot 10^5$ MPa. Tests were performed in a UE-50 machine with axial tension cycling at a frequency of 0.5 Hz, to a total of 120,000 cycles. Measurements and photographs taken throughout the process reveal, upon correlation with the static fracture model, that cracking under a slowly cycling load proceeds in three stages: 1) linear elastic crack growth; 2) elastoplastic crack growth; 3) quasi-static crack growth up to fatigue failure. Transition from elastoplastic to quasi-static cracking occurs as the nominal net stress has built up to the yield strength level. Cracking becomes unstable as the crack opening reaches its critical width under short-duration static load. Figures 4; references 2: both Russian. [29-2415]

UDC 621.791.753.5:62-413

AUTOMATIC MULTI-LAYER WELDING OF THICK CYLINDRICAL STRUCTURES UNDER FLUX

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 84 pp 12-13

PILIPENKO, N. V., engineer, RUDENKO, Yu. N. and YASTREB, A. N., engineers, Novokramatorsk Machine Building Plant

[Abstract] The authors' plant has set up a section for manufacture of thick cylindrical structures such as hydraulic press cylinders and supporting rolls using automatic welding under flux. The system of equipment used allows

assembly, preliminary heating and welding of cylindrical products. The system consists of a specialized assembly stand, a portal installation with welding equipment, an installation for conduction heating of blanks and cleaning of seams, and a vertical furnace for stress relief after welding. A photograph of the assembly and welding installation and a photograph of the automatic multilayer welding process are presented. The macrostructure of a cylindrical welded joint is illustrated. Products up to 500 mm thick can be automatically welded in a narrow slot. The mechanical properties of welded joints produced under AN-43 flux have been found to satisfy the requirements of the technical conditions. The technology has been used to produce a supporting roll shaft for a rolling mill and a hydraulic press cylinder with a wall thickness of 400 mm.
[022-6508]

UDC 621.791(754'293+72).01:669.018.4

SOFTENING OF METAL NEAR SEAM DURING WELDING OF HEAT-RESISTANT NICKEL ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 84 pp 5-6

YAKUSHIN, B. F., candidate of technical sciences and FEDOROV, B. M., engineer

[Abstract] The EP693 heat-resistant alloy containing Ti and Al, as well as EP914, containing Nb and Al, were employed in a study of softening of the metal near the seam in welding of nickel alloys. Hardened sheet specimens 1.5 mm thick were treated by electric heating using a welding thermal cycle in order to determine the time required for dissolution or coagulation of the hardening phase. After imitation of the welding cycle the mechanical properties of the specimens were determined at 800°C, i.e., in the dispersion hardening temperature interval. It was found that for EP693 holding at over 950°C for more than 1.8 seconds resulted in a great decrease in heat resistance, resulting from coagulation or partial dissolution of the hardening phases. For EP914, heat resistance decreases if the metal is held at over 950°C for more than 3.0 second, a result of the lower diffusion mobility of Nb in comparison to Ti. This indicates the advantage of electron beam welding methods over arc welding, since the time the metal spends at high temperature is significantly reduced. Figures 5; references 8: all Russian.
[022-6508]

UDC 620.193.013:669.018.8

CORROSION-RESISTANT AMORPHOUS ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 4, Jul-Aug 84 (manuscript received 26 Aug 83) pp 3-10

SHVETS, V. V. and BABEY, Yu. I., Physics-Mechanics Institute imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] This review of the Soviet and Western literature discusses corrosion-resistant amorphous alloys of transition metals with metalloids such

as P, B and C obtained by rapid cooling from a melt. The structure of the alloys does not have the characteristic long-range order of crystalline alloys. Studies of the corrosion of amorphous alloys have developed in relationship with the problem of the structural specifics of these materials and as the applied problem of creating new commercial corrosion-resistant materials. The anomalously high corrosion resistance of amorphous alloys and their capability for passivation in corrosive media are explained not only by the presence of specific alloying elements, but also by structural specifics such as the lack of grain boundaries, dislocations, and macro- and micro segregations. The addition of molybdenum, tungsten, titanium and vanadium is very effective in increasing the corrosion resistance of iron- and cobalt-based amorphous alloys. The unique corrosion properties of amorphous alloys make them quite promising as corrosion-resistant materials. The authors have studied the corrosion properties of the alloy $Fe_{65}Cr_{11}B_{19}Si_4$ in the cast state and after laser irradiation to make the surface amorphous. Metallographic studies have shown that after laser treatment the roughness of the surface is reduced and is characteristically shiny and reflective. The white surface layer does not etch. Powerful pulsed plasma fluxes might be a promising means for shaping amorphous alloys. Ion implantation is an effective method of producing amorphous layers on the surface of metals and alloys. The corrosion resistance of ion-plasma coatings on metal substrates is shown to be high. Figures 8; references 33: 16 Russian, 17 Western.
[013-6508]

UDC 539.25

STRUCTURE OF AMORPHOUS FILMS OF ALLOYS BASED ON Fe, CONDENSED FROM LASER EROSION PRODUCTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 5, Oct 84 (manuscript received 22 Apr 83) pp 1120-1122

SKAKOV, Yu. A., ALEYNIKOV, V. S., BONDARENKO, Yu. F., VORONOVA, M. I., YEDNERAL, N. V., IVANOV, Yu. N. and SHEVENKOVA, N. V.

[Abstract] Films from molecular clusters typically have acicular structure and a directional growth pattern that approximate the direction of the molecular flow. The present article reports on atomization of a number of alloys by laser irradiation. The alloys tested were Fe-10Cr-4Si-16B, Fe-10Cr-13P=7B and Fe-10Cr-10B-10C. Films were deposited on KCl crystals, then separated in distilled water and examined by an electron microscope. Results showed that relatively low-energy uncharged particles were distributed in the direction of the laser impulse, yielding a thin amorphous film like a coating of Fe_3O_4. Only a small part of the ion-vapor cloud resulting from the laser impulse left the zone of the laser's impact. Changes in structure were noted as the condensate began to form high-density coatings in some locations that had a higher tendency toward oxidation. Such zones depended in size on the alloy and varied from 10 to 150 nm. It was shown that laser atomization is effective for obtaining amorphous films with homogeneous dense structure, but heating of the film during condensation must be taken into account. References 5: 4 Russian, 1 Western.
[41-12131]

UDC 669.018:539.26:161.58

ENERGY SPECTRUM OF PROCESSES OF STRUCTURAL RELAXATION OF AMORPHOUS ALLOY $Fe_5Co_{70}Si_{15}B_{10}$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 5, Oct 84 (manuscript received 9 Feb 84) pp 1115-1120

KEKALO, I. B., TARANICHEV, V. Ye. and TSVETKOV, V. Yu., Moscow Institute of Steel and Alloys

[Abstract] Amorphous alloys are known to lack metastable balance after tempering due to the freezing of various defects into their structure. The present article reports on energy parameters of the process of single-axis anisotrophy of relaxation of tension in an amorphous alloy with the composition $Fe_5Co_{70}Si_{15}B_{10}$ after tempering from a molten state. Changes in physical structure during structural relaxation were related to rearrangement in the amorphous phase beginning at temepratures below 250°C. A temperature range of 185-340°C was studied to determine kinetics of these changes. Data obtained were analyzed on the basis of a log-normal distribution of relaxation times. Results showed that at temperatures below 230°C the elimination of excess free volume was weak and relaxation of tension took place in the amorphous matrix. The spectrum of activation energy was very narrow. Mathematical calculations of these processes are presented. Figures 4; references 14: 4 Russian, 10 Western.
[41-12131]

UDC 536.5:535.21:546.26:536.50

EXPERIMENTAL STUDY OF ENTHALPY OF QUASIMONOCRYSTAL OF GRAPHITE AND CARBON GLASS IN TEMPERATURE RANGE OF 2890-3818°K

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[Abstract] Despite extensive theoretical and experimental study, little dependable information is available on thermodynamic properties of graphite at above 3000°K. The present article reports on UPV-1T graphite, a graphite quasimonocrystal, and carbon glass, as representatives of brittle non-graphite carbon materials. Enthalpy was measured by a mixing method after heating in an argon medium, using a sum of internal energy variations in a Debayev approximation, the energy of heat expansion and electronic values as parameters. Results showed that the experimental enthalpy balues for the two materials coincided in the range where accurate measurements could be made. X-ray data

and calculations of thermodynamic values in a temperature range of 300-5000°K suggested the need for considering the thermodynamic state of the solid phase in determining the balance between gas and solid states and the phase diagram structure of the materials tested. Figures 1; references 11: 9 Russian, 2 Western.
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